MESSTECHNIK

Technical Documentation

Technische Beschreibung

KONTRON ELECTRONIC GROUP

KONTRON MESSTECHNIK

MP MASTER
MA23290

SCIMITAR H'

KONTRON ELEKTRONIK GRUPPE
KONTRON MESSTECHNIK

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KONTRON LOGIC ANALYZER OPERATION AND MAINTENANCE MANUAL

KLA-5000-01

December 1982

REVISION HISTORY

Title	Number	Date	Notes
Kontron Logic Analyzer Operation And Maintenance Manual	KLA-5000	12/82	First Edition

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PREFACE

The scope of this manual is limited to the basic user instructions and theory of operation of the KLA.

Chapter 1, Introduction, describes the general KLA hardware interactions, and design features.

Chapter 2, Specifications, describes operational and hardware specifications.

Chapter 3, User's Guide, describes the operational features; keyboard controls, diskette, and connections, and also gives detailed instructions on how to use the menus to set parameters, and to record data.

Chapter 4, Theory Of Operation, describes the various circuit boards and the interactions of the signals in the operation of the KLA.

Chapter 5, Glossary, explains concepts and terms generally applicable to logic analyzers, and specifically as used with the KLA.

Chapter 6, Options, will be added as new enhancements to the KLA, in the form of options, become available.

Chapter 7, Schematics/Pin Assignments, provides the schematics that are available at the publication date of this manual.

Please note that a **Documentation Reply Card** is inserted at the back of this manual. When you complete and return it, you help us produce better documentation for you.

A **User Registration Card** is included in the set of manuals you receive with your Kontron system. When you complete and return the User Registration Card, you ensure that you will receive all updates and new information for your configuration.

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KONTRON SERVICE NUMBERS

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CHAPTER 1

INTRODUCTION

The Kontron Logic Analyzer is a menu driven instrument with flexible multilevel triggering, up to four clocks, time and data display capabilities for the analysis of hardware and software development. It also provides glitch memory, glitch capture, and glitch triggering, along with timing diagrams to simplify hardware analysis.

For all its complex features, the KLA has a effective menu system which is user friendly. Screen instructions guide the user from the simple to the more complicated menu settings.

The operating system is stored on a floppy disk, therefore updating or adding options is relatively simple. Complete settings can be stored on additional diskettes to simplify the system setup procedure.

The hardware and sofware design of the KLA includes four subassembly groups. See also **Figure 1-1, KLA Block Diagram**

1. Time Base and Qualifier Board--four inputs for the external clock, clock qualification and connection, time basis for internal clock.

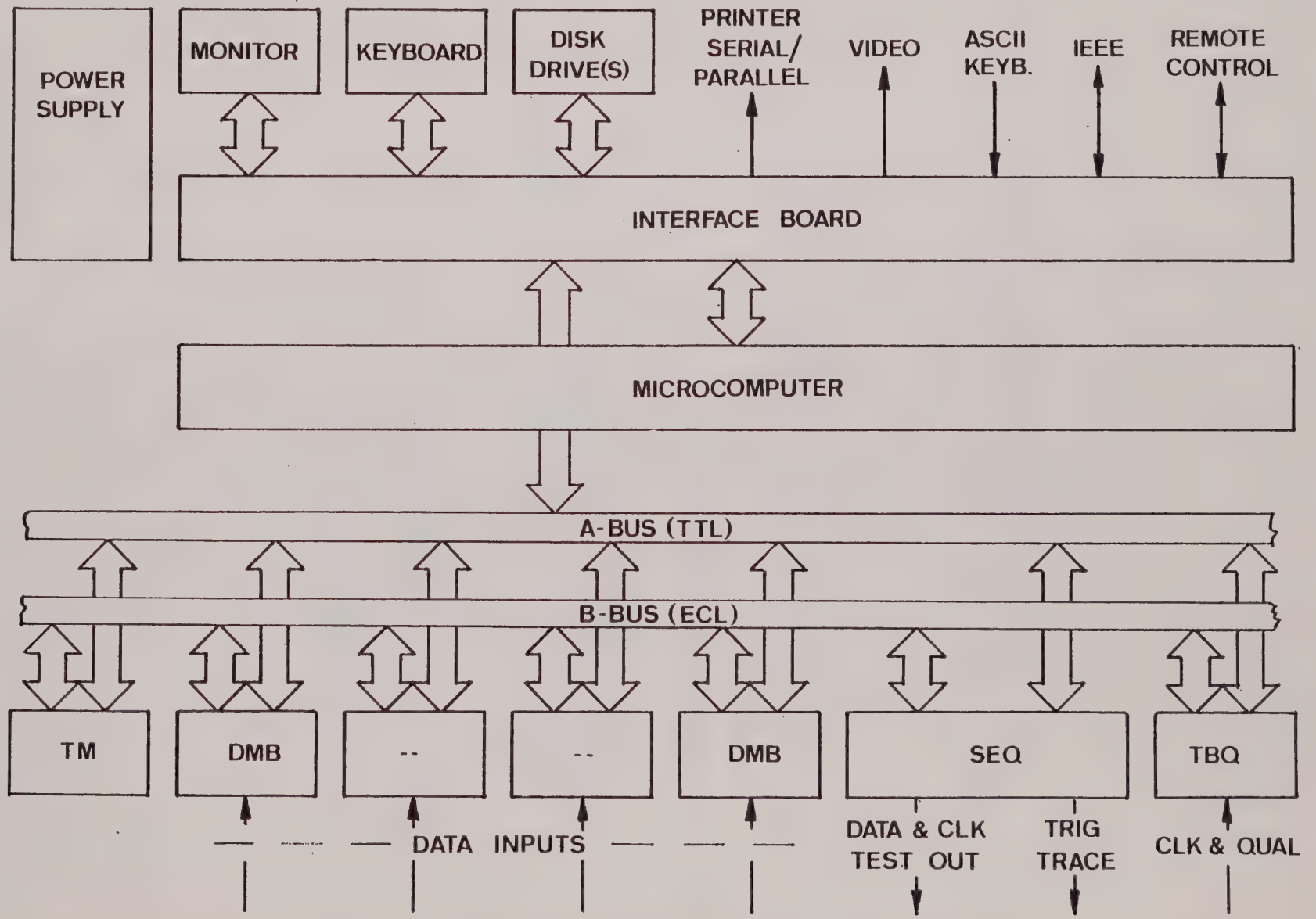
2. Trigger Sequencer Board--trigger processing and control of recording processes.

3. Four Memory Boards for KLA-64
   In Non-Interlace Mode--16 data inputs each, with maximum clock rate of 50 MHz, and a memory depth of 2K bits per channel.
   In Interlace Mode--8 data inputs each, with a maximum clock rate of 100 MHz, and a memory depth of 4K bits per channel.

4. Time Measurement Board (TM Option)--Optional time measurement board with 10 ns resolution with external clocks, for storing time information during data qualified recording or transition recording. It stores measured times more than 32 bits wide and 2K deep.

The processor control consists of a Z80A based group, with a floppy disk controller, a CRT controller, 256K RAM, two serial and one parallel interface (optional), and memory expansion of 256K RAM. The four assembly groups listed on the previous page are connected to processor via the ECB bus. The IEEE-488 interface option can be connected to this bus. In turn, the ECB bus is connected to a TTL bus, and an ECL bus, through another interface.

All software necessary to run the analyzer is immediately loaded from the diskette into the working memory of the CPU when the device is turned on, so that the diskette is accessed only for dumping or reloading of setup files or reference files. There are two system diskettes in the standard shipment. Only diskettes that contain the KLA system software should be used. Additional diskettes are available from Kontron Electronics, Inc.


POWER SUPPLY
MONITOR
KEYBOARD
DISK DRIVE(S)
PRINTER SERIAL/ PARALLEL
VIDEO
ASCII KEYB.
IEEE
REMOTE CONTROL
INTERFACE BOARD
MICROCOMPUTER
A-BUS (TTL)
B-BUS (ECL)
TM
DMB
--
--
DMB
SEQ
TBQ
DATA INPUTS
DATA & CLK TEST OUT
TRIG TRACE
CLK & QUAL

CHAPTER 2

SPECIFICATIONS

2.0 OPERATING SPECIFICATIONS

2.1 CONFIGURATION: NON-INTERLACE MODE

KLA 64	KLA 48	KLA 32
64 channels	48 channels	32 channels
48/16 channels	32/16 channels	16/16 channels
32/32 channels	16/32 channels	
32/16/16 channels	16/16/16 channels	
16/16/16/16 channels		

2.2 CONFIGURATION: INTERLACE MODE

KLA 64		KLA 48		KLA 32	
Interlace Channels	Non-Interlace Channels	Interlace Channels	Non-Interlace Channels	Interlace/Non-Interlace Channels	
16	32	8	32	8	16
32	—	24	—	16	--

2.3 CLOCKS:

Internal clocks to 100 MHz in interlace mode
to 50 MHz in non interlace mode
External clocks to 50 MHz with rising or falling edge selectable as active.

2.4 MEMORY

Memory Depth:	2048 bits per channel; double in interlace mode to 4096 bits.
Triggering:	Up to 14 levels

2.5 DISKETTE MEMORY:

5 1/4", double density, double sided, 77 tracks, 96 tpi

Capacity:	560K
Store/Recall	10 device settings, 10 reference files, can be stored under user assigned mnemonics.

2.6 DATA DISPLAY:

Binary, Octal, Decimal, Hexadecimal, ASCII, EBCDIC individually selectable for each channel group.

2.7 INPUTS:

Data Inputs:	8 inputs per data probe
Clock Inputs:	2 clock probes, each with 2 clock inputs plus 6 clock qualifier inputs.
Input Impedance:	1 Megohm, $\leq$ 5pF
Input Voltage: Max.	$\pm$ 50 volt continous, $\pm$ 100 volt transient
Thresholds:	TTL(+1.4V), ECL(-1.3V), 4 variable thresholds ($\pm$ 12.7 V in 100 mV increments) selectable pod by pod.
Setup Time:	Data must be present 2 ns before active clock edge
Hold Time:	Data must be present 2 ns after active clock edge.
Skew:	2 nanoseconds channel to channel typical

2.8 OUTPUTS

Printer Interfaces:	RS232-C Parallel interface Centronics compatible
Remote Interfaces:	RS232-C IEEE-488 (1975)

Baud Rate:	110...9600
Bits/Symbol	5, 6, 7, or 8
Stop bits	1. 1.5, or 2
Parity:	even, uneven, or none
Trigger Outputs:	TTL
Video Output:	Composite video 75 Ohm 1 Vp-p

2.9 HARDWARE MECHANICAL SPECIFICATIONS

Dimensions: 45 W x 21 H x 58 D cm (18 x 4.4 x 23.2 in.) without handle

Weight: (KLA 64) approx. 29 kg. (64 lbs.)

CRT: 9 inch CRT with 80 characters and 24 or 26 lines.

Power: 115/220 volt RMS, $\pm$ 10%, 400 VA

CHAPTER 3

USER'S GUIDE

3.1 RECEIVING INSTRUCTIONS AND SELF TEST

3.1.1 LIST OF ITEMS IN SHIPMENT

The KLA when shipped in its standard configuration includes the following parts:

PROBES:

KLA 64	10 probes numbers 1 through 8 and also J and K clock pods
KLA 48	8 probes numbers 1 through 6 and also J and K clock pods
KLA 32	5 probes numbers 1, 2, 5, and 6 and also J clock pod

PROBE CONNECTOR SETS

KLA 64	10 sets each consisting of a flat plug with 9 input circuits, and 9 test clips.
KLA 48	8 sets
KLA 32	5 sets

DISKETTES

Two diskettes each labeled with KLA model number and version X.X

POWER CABLE

TWO MULTICOLOR RIBBON JUMPER CABLES

OPERATION AND MAINTENANCE MANUAL KLA-5000-01

3.1.2 TURNING ON THE POWER

Before turning on the unit, make sure that the power specified on the back identification plate of the KLA agrees with your power source. If a change from 110 to 220 or vice versa has to be made, please call your Kontron Service number.

CAUTION: To protect your diskette, do not turn the power off while a READ/WRITE is in progress. However, the diskette may be left in place while turning the power on or off, provided that it is not reading or writing.

3.1.3 INCOMING INSPECTION

1. Plug in the power cord. Push start button. The fan motor should start up. If the fan motor does not start up, check the power connection and the plug. If the fan still does not turn on, there may be a problem with the cord, or the fan or the internal power supply. Call you Kontron representative for help.

2. After the fan starts up, open the keyboard panel by pulling forward from the upper right hand corner. Insert the system diskette, which you received with the unit, into the drive slot with the top arrow pointing in the direction of the disk drive. **Figure 3-1, Disk Drive Slot.** Close the disk drive door smoothly and gently.

3. Push the green power switch in the lower right-hand corner of the front panel. The system should boot up a few seconds later. If nothing appears on the screen, something may be wrong with the CRT. Call your Kontron representative. If only a blinking cursor appears, the disk drive may be faulty, or the diskette may be blank. Repeat the boot up procedure by turning the ON/OFF switch several times. If still only the blinking cursor appears, or an ERROR message appears, call your Kontron representative for help.

4. The first display, which stays on for about 15 seconds, is a status menu, showing which boards are installed and which probes are connected to the system. See **Figure 3-2, Status Menu.** If it disappears before you have a chance to read it, turning the system off and on again will reboot and bring it up once more.

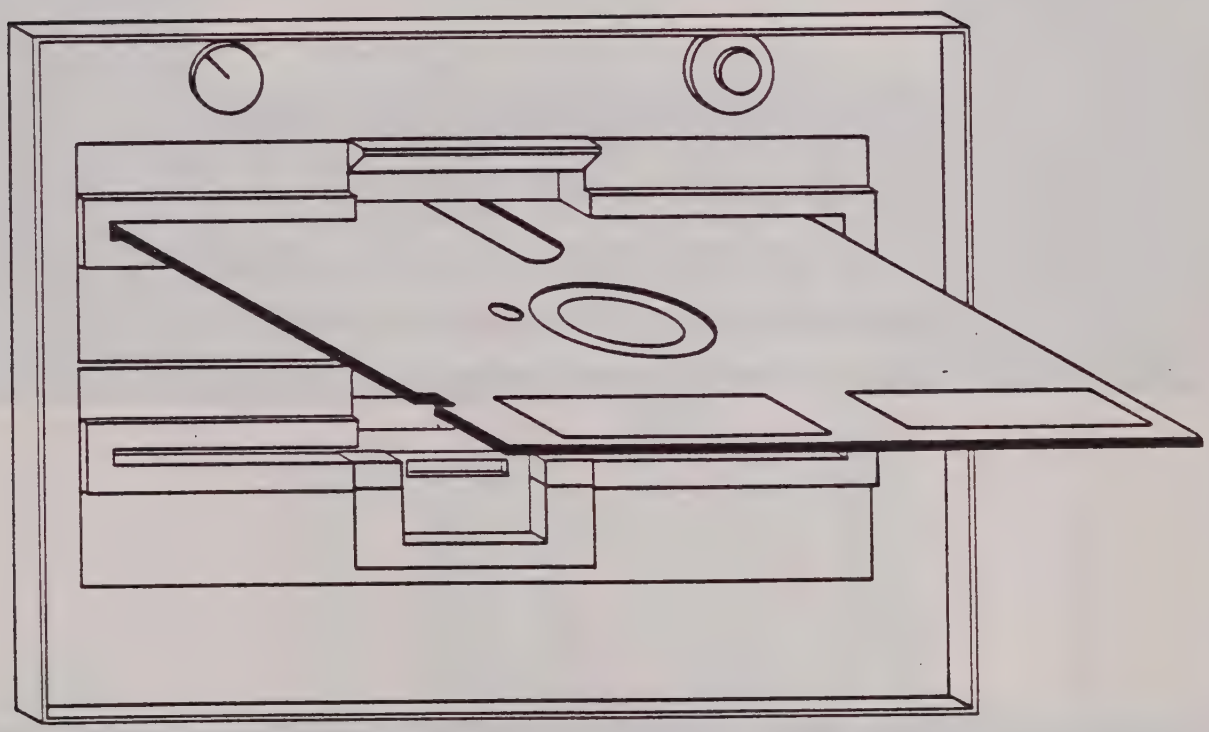


Figure 3-1 Disk Drive Slot

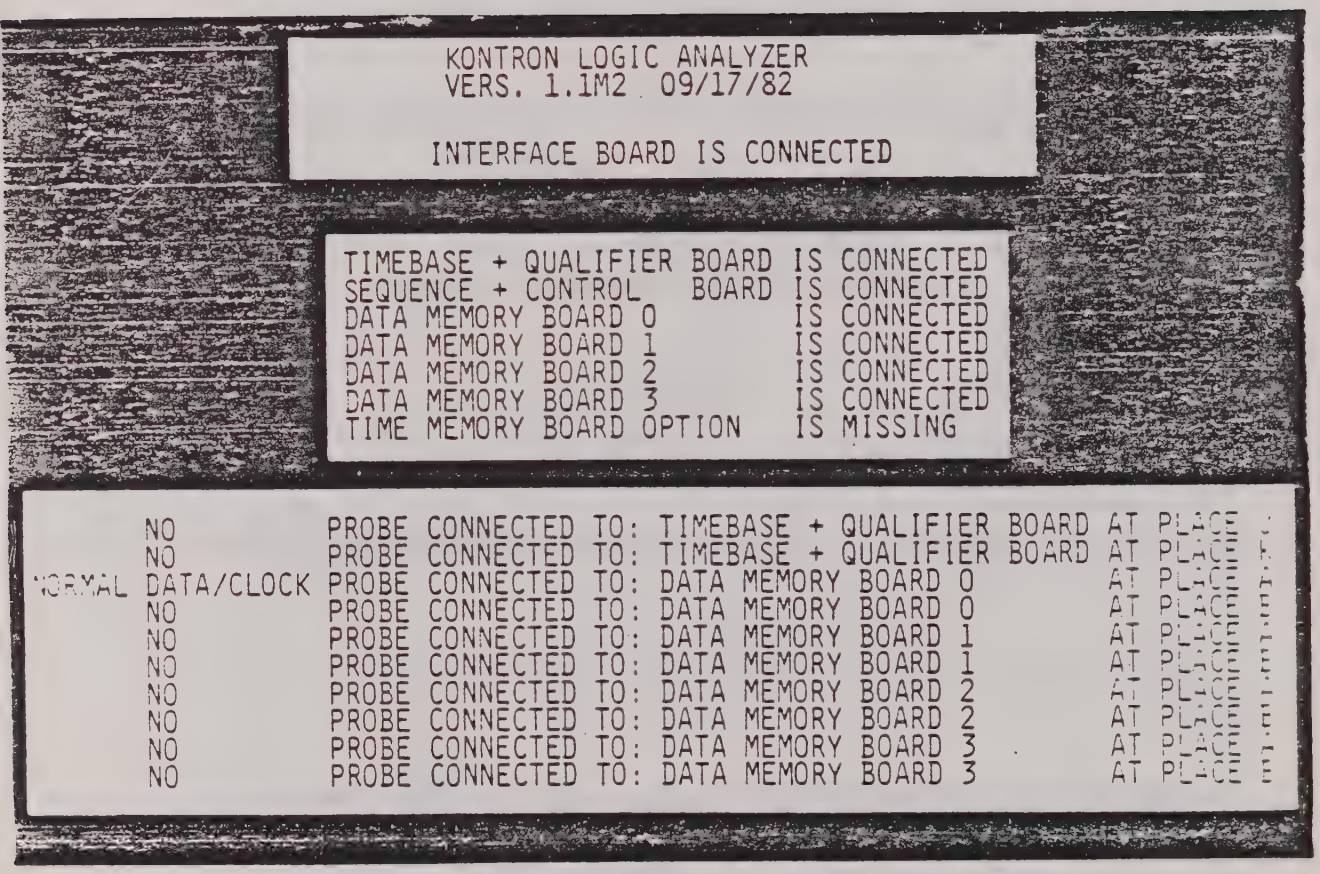
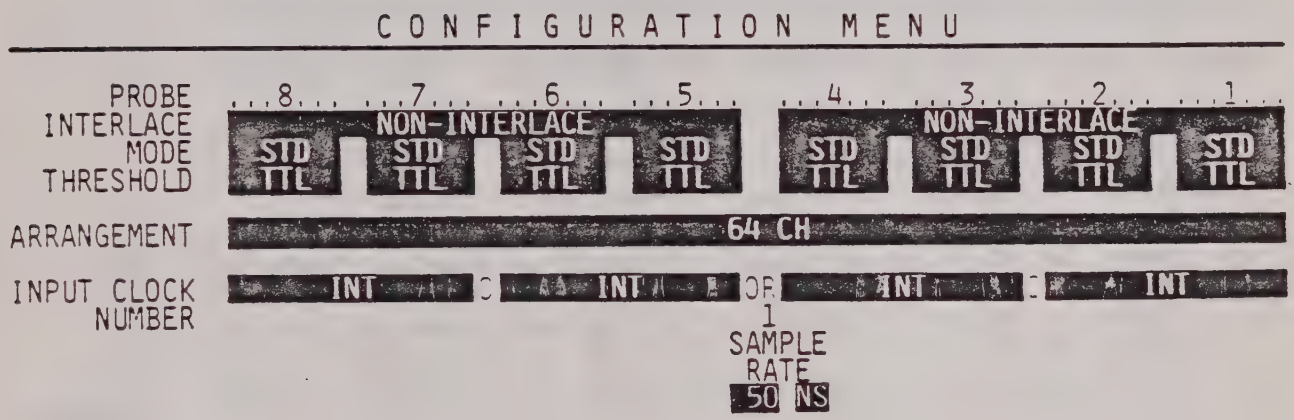

KONTRON LOGIC ANALYZER
VERS. 1.1M2 09/17/82
INTERFACE BOARD IS CONNECTED
TIMEBASE + QUALIFIER BOARD IS CONNECTED
SEQUENCE + CONTROL BOARD IS CONNECTED
DATA MEMORY BOARD 0 IS CONNECTED
DATA MEMORY BOARD 1 IS CONNECTED
DATA MEMORY BOARD 2 IS CONNECTED
DATA MEMORY BOARD 3 IS CONNECTED
TIME MEMORY BOARD OPTION IS MISSING
NO PROBE CONNECTED TO: TIMEBASE + QUALIFIER BOARD AT PLACE
NO PROBE CONNECTED TO: TIMEBASE + QUALIFIER BOARD AT PLACE
NORMAL DATA/CLOCK PROBE CONNECTED TO: DATA MEMORY BOARD 0 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 0 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 1 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 1 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 2 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 2 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 3 AT PLACE
NO PROBE CONNECTED TO: DATA MEMORY BOARD 3 AT PLACE

Figure 3-2 Status Menu

5. Next, the menu shown in **Figure 3-3, Configuration Menu** will appear.

6. The back panel of the KLA has labeled sockets. Connect all the data and clock probes into the appropriate sockets on the back panel, as shown in **Figure 3-7, Back Panel Connections**



TRG LOCATION -0253 +1792
NON-INTERLACE PROBES 8 7 6 5 4 3 2 1
TIME, INT CLK -012.65 US +089.60 US

ROLL TO DESIRED SELECTION

Figure 3-3 Configuration Menu

7. Take the two flat ribbon jumper cables which were shipped with the unit. Plug one into the CLOCK PROBE TEST TERMINAL, and the other into the DATA PROBE TEST TERMINAL. Attach the second end of the CLOCK PROBE TEST TERMINAL to the J Clock Probe. Attach the second end of the jumper cable from the DATA PROBE TEST TERMINAL to Data Probe 1. Now check out your unit according to the procedure in the following section.

3.1.4 SELF TEST

Refer to the CONFIGURATION MENU displayed on the screen to perform the self test operation.

1. Note the blinking NON-INTERLACE/NON-INTERLACE field at the top of the menu. This field is a parameter field with the parameter cursor in it. The parameter cursor can be moved around the menu to other fields, using the four yellow movement keys:

2. Move the blinking parameter cursor field down to THRESHOLD. This field is divided into eight video blocks corresponding to the eight probes. Use the orange **ROLL UP** or **ROLL DOWN** key to change the alternatives in this block until ECL is displayed. Use the yellow directional cursor keys to move into each separate parameter field and change all of them to ECL by rolling up or down.

3. Move the parameter cursor down using the yellow directional cursor key to the parameter field labeled INT. Move horizontally to the parameter field on the extreme right. Use the orange **ROLL UP** or **ROLL DOWN** key to select +JO. The other three blocks should be OFF. Move into each field with the horizontal cursor to change each one to OFF if necessary.

4. Move the parameter cursor to the left side of the display to the field J:TTL. Use the orange **ROLL UP** key to change this to J:ECL. The menu should look like **Figure 3-4, Self Test Menu Display.**

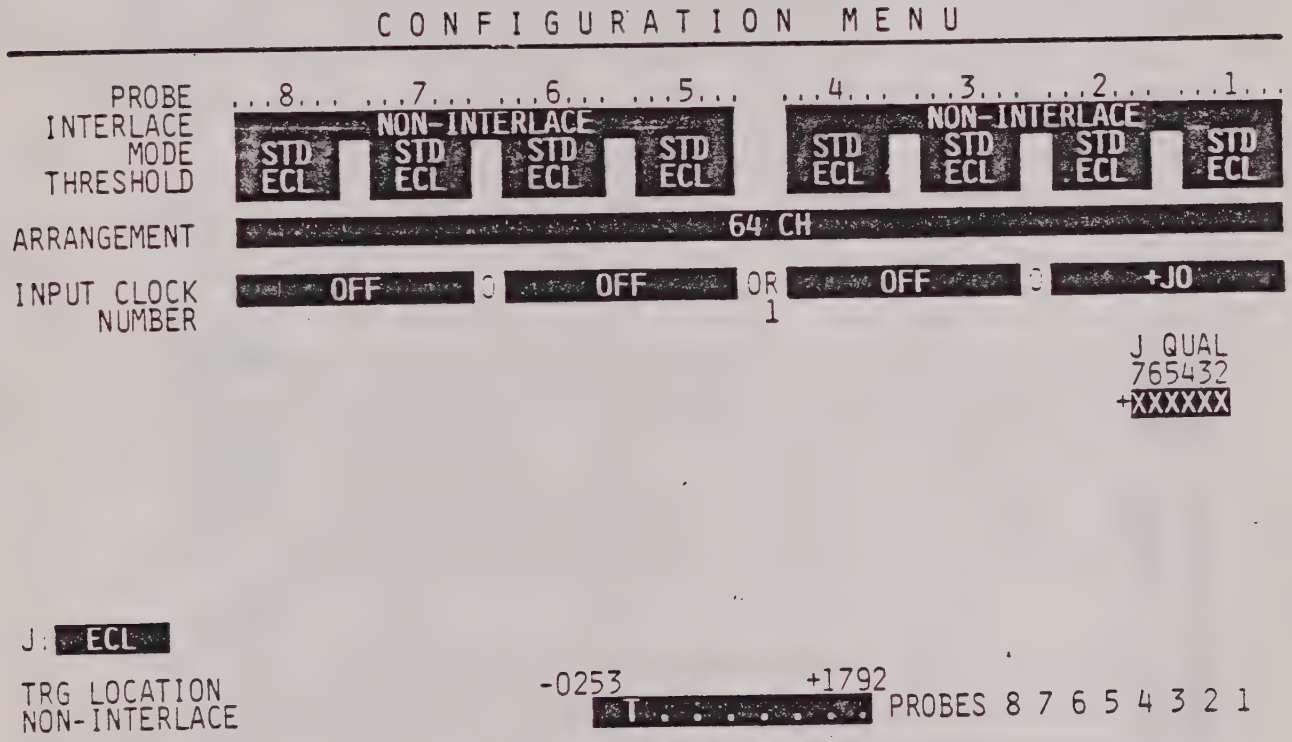


Figure 3-4 Self Test Menu Display

5. Press the red **RUN/STOP** key in the lower right hand corner of the keyboard. This instructs the KLA to store data in memory.

6. Press the white **TIMING** key in the upper right hand corner of the keyboard. This will display all sixteen channels of the timing diagram on the screeen. The left hand column consisting of two digits represents the probe number and the input to that probe. For example, number 15 represents probe 1 and input 5 on probe 1. The input 0 is the LSB and the input 7 is the MSB. All eight inputs should have data displayed. See **Figure 3-5, Timing Diagram Display.** This test indicates that this portion of KLA memory and this probe are functioning properly. Call your Kontron representative, if you suspect any problems.

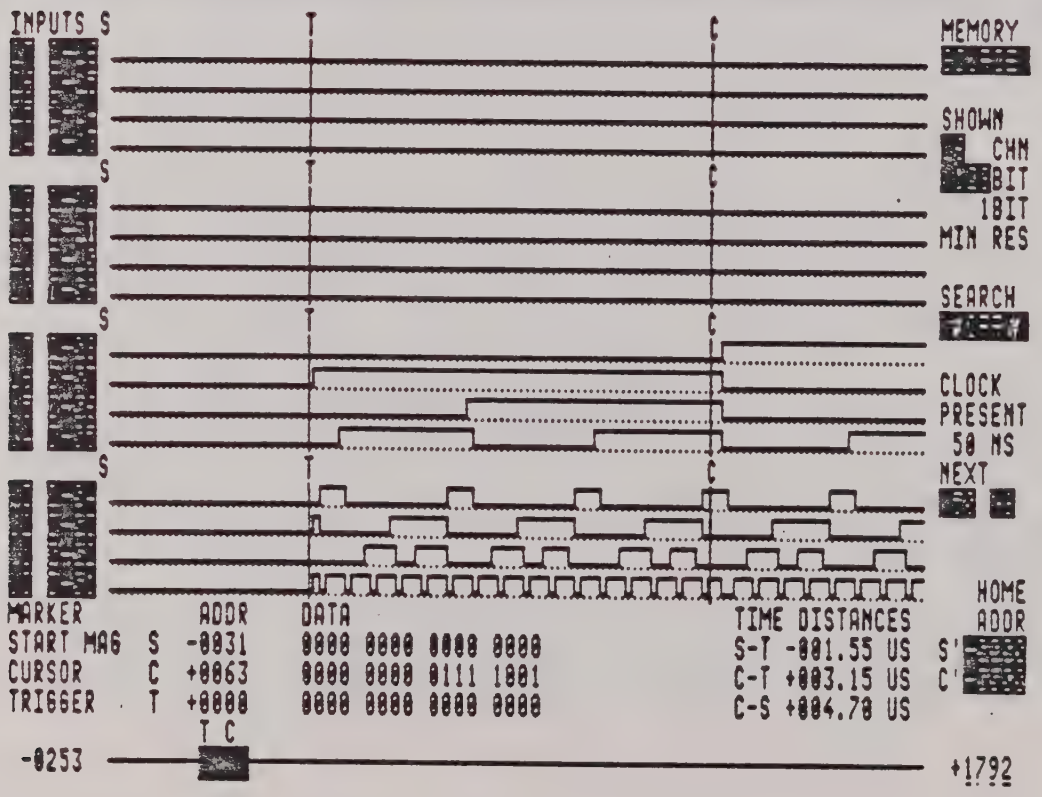


Figure 3-5 Timing Diagram Display

7. Disconnect Probe 1 from the jumper cable and connect Probe 2 to the same jumper cable. Press the **RUN/START** button again to display Probe 2 (positions 20 to 27). Continue checking each probe and its binary patterns by connecting them to the jumper cable one by one and recording the data.

8. Now scroll through the data by pressing the orange **SCREEN** key, and then the yellow vertical directional cursor key. Each keystroke will scroll through the data, four channels at a time, and this is necessary to examine the remainder of the probes.

9. On the KLA 64 and KLA 48, the K clock probe should be tested. Remove the J clock probe from the jumper cable and attach the K probe. Leave the data probe attached. Return to the CONFIGURATION MENU by pressing the white roll key until it appears. Press the orange **FIELD** key to make the blinking parameter cursor appear. Move the parameter cursor to the to the INPUT CLOCK field and move horizontally to the second block from the left. Press the orange roll up key and +K0 should appear. Move the parameter cursor horizontally to +J0, and change this to OFF by using the roll down key. Now move the parameter cursor to the left side of the screen and change K:TTL to K:ECL as in step 4 above in this section.

10. Press the **RUN/STOP** key, and the **TIMING** key. The timing diagram with the binary count should now be displayed.

This completes the incoming inspection and self test.

3.2 FRONT PANEL CONTROLS AND BACK PANEL CONNECTIONS

The front panel of the KLA (See **Figure 3-6, Front Panel Controls**) has the following controls:

1. Power switch with a green indicator light
2. Keyboard

And behind the keyboard which opens forward:

3. Disk drive
4. System reset switch
5. Brightness control

The backpanel of the KLA (See **Figure 3-7, Back Panel Connections**) has the following input and output connections:

6. Power plug with shield
7. Video output
8. Interfaces
9. Probe connections, trigger output, trace output.

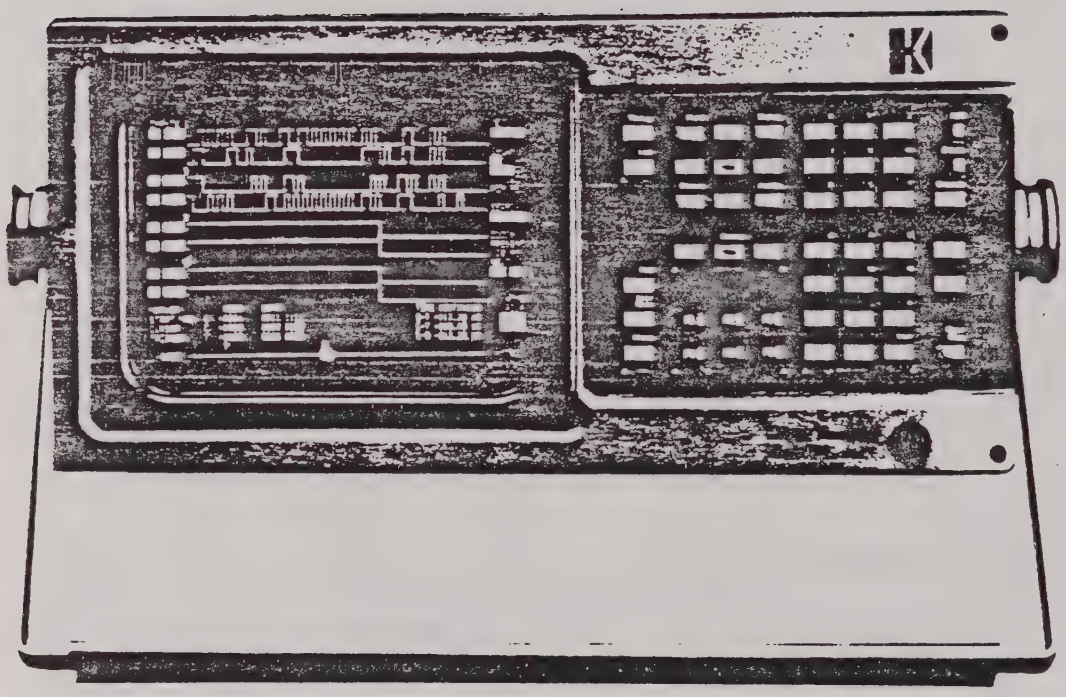


Figure 3-6 Front Panel Controls

3.2.1 THE SYSTEM DISKETTE

The disk drive for the KLA is immediately behind the keyboard. There is a depression on the right front edge of the housing. Open the keyboard by holding the depression and pulling forward and down. The brightness control and the system cold start reset button are located below the disk drive slots.

Open the disk drive by pushing the lever up. Remove any protective white cardboard found in the disk drive. Hold the diskette with the label towards the top, and the oval read/write window forward. Insert until the diskette clicks in place, but be careful not to bend the it. Close the drive door by pulling down the lever slowly until it stops. If the drive door is closed too fast, the diskette may not center properly. See **Figure 3-1, Inserting The Diskette.**

The diskette does not need to be removed before turning the power on or off. When the power is turned on with the diskette in place, the boot program automatically searches for, and loads the operating system into memory. If this does not happen automatically, push the system reset button next to the disk drive. The system should reboot.

For formatting and copying the system diskettes use the KLA utilities disk. Please contact you Kontron representative if you need system diskettes. Each diskette must contain the operating system. Only the diskettes supplied with the device, or factory supplied copies can be used in the unit. Please give your KLA serial number when reordering diskettes from Kontron.

3.2.2 KEYBOARD

The KLA keyboard is divided into functional key groups, and individual control keys. Refer to **Figure 3-34, KLA Keyboard** which is on a fold out page located at the end of Chapter 3. The keys are identified by callout numbers in this Figure 3-34. The same callout numbers are used when referring to specific keys throughout this manual.

KEY	NAME	FUNCTION
1	ROLL	Menu callup or selection from the menu set selected with Key 2. Repeated pressing of this key will switch between menus of the set selected by Key 2.
2	STD/ SPEC	Switching between the two sets of menus: the standard set and the special set. The standard set consists of Configuration Menu, Trigger Word Menu, and Trigger Sequence Menu. The special set consists of Compare Menu, I/O Menu, and Store/Recall Menu.
3	RESET	This key loads the setup file 0 (the default file) from the diskette, and sets or restores all the parameters stored in this file.

KEY	NAME	FUNCTION
4	TIMING	This key displays the timing diagram.
5	LIST	This key displays the data list.
6	CURSORS	These four directional cursor keys position the parameter cursor when FIELD mode is selected with Key 7.
7	FIELD	This is the FIELD setting key for all directional cursors, identified as key sets 6 and 11. Key group 6 moves the parameter fields in the menus and the displays. In parameter fields with several places, the two directional keys numbered 11 move the parameter cursor one place at a time (intrafield cursor). FIELD setting remains valid until SCREEN key 8 is pressed.
8	SCREEN	This is the SCREEN setting for key groups 6 and 11. It allows the user to scroll through the data display vertically to select the memory segment to be displayed, or horizontally to page through the data. In the timing diagram display it scrolls horizontally to select the channels to be displayed. The SCREEN setting remains in effect until the FIELD key is pressed.
9	ROLL UP/DOWN	These are the ROLL UP and ROLL DOWN keys, which scroll through the selections available in a blinking parameter field. First the parameter field is selected with key group 6, then either the ROLL UP or the ROLL DOWN key can be used to rotate through the selections.
10	HOME	This is the HOME key for executing jumps from the beginning of magnification, or the beginning of the data list S, to a preset home address S'.
11	CURSORS	These are two directional cursor keys which position the parameter cursor in the parameter fields when the FIELD key 7 is pressed, or position the cursor in time and data displays when the SCREEN key 8 is pressed.
12	HOME	This is the HOME key for executing jumps from the time or data display to a preset home address C'.
13	ALPHA-NUMERIC	This is the alphanumeric keyboard. Letters J through Z are reached by pressing the shift key 14 for each letter. **For mnemonic input, the letter X is input by shift G. Shift X key inputs a space.** Numeric keys 1 to 4 can be used in the timing display to switch the magnification factor, where x 4 is the highest magnification. This magnification change is possible only when the parameter cursor is not on a numeric input field.

KEY	NAME	FUNCTION
14	SHIFT	This is the SHIFT key. Letters J through Z are reached by first pressing the shift key for each letter. Pressing the shift key twice restores the character printed on the key itself.
15	X	This is the letter X key, which is the X=don't care input or the space key for mnemonic input. X=don't care in the trigger or qualifier words means do not read these bits during triggering or data or clock qualifying. X=don't care in the channel distribution line in the trigger word menu deletes that channel. X=don't care can also be used to switch off probes not checking data change in transition recording, or channel groups not being compared in the compare menu.
16	POLARITY	These are the polarity change control keys.
17	ADD	This key will insert a new column to the right of the column marked with the parameter cursor.
18	DELETE	This key removes columns marked with the blinking parameter cursor from the data display. If the parameter cursor is on the mnemonic or master clock field in the trigger word menu, the DELETE key will set a don't care setting for the whole trigger word. The DELETE key resets a trigger level in the trigger sequence menu. It also resets a trigger monitor in the trigger sequence.
19	EXECUTE	The EXECUTE key will execute a search in the timing or data display, execute a diskette read/write in the STORE/RECALL menu, or it will start and stop cyclic recording and comparison in the COMPARE menu.
20	START/ STOP	START/STOP key starts recording, or stops recording when trigger conditions have not been fulfilled by positioning the trigger marker at the end of memory. In the Compare Menu, it will execute a one-shot comparison. If the START/STOP key is pressed in the middle of a procedure in the Compare Menu, it will stop comparison at the end of the first operation in progress.
21	FUNCTION	These are the special function keys for calling up software options. Key F1 is for sending a test string in the I/O menu for interface test, or to output the menu or display which is immediately on the CRT.

3.2.3 BACK PANEL CONNECTIONS

Refer to **Figure 3-7, Back Panel Connections** to identify KLA input and output connections.

1. Power Connection

2. Video Output (BNC 1V p-p, 75 Ohm)

3. Printer Interface (RS-232C parallel output, Centronics compatible) This is discussed in detail in Section 3.3.3.3.

4. RS-232C Interface for remote control (Option) See Section 3.3.3.3.

5. External ASCII keyboard connection (Option)

6. Data Probe connections

7. Clock Probe connections

8. Test Output For Data Probes. This output has an 8-bit ECL counter, which is a BCD counter with a 10 microsecond cycle, where HIGH = 100 nanoseconds, and LOW = 100 nanoseconds. When connected to a data probe, the least significant bit (LSB) for this counter appears at pin 0 and the most significant bit (MSB) at pin 7. Since this is a BCD counter, address errors of the recording memory can be recognized from the recording of this signal.

9. Test Output For Clock Probes. This output is used to test clock probes J and/or K. When probe J or K is plugged to this connector, there is an FCL signal at pins 0 and 1 with a period length of 100 nanoseconds (HIGH = 40 nanoseconds, LOW = 60 nanoseconds). This signal is synchronous to the ECL counter located at the test output for data probes discussed as connector 8 in the paragraph above. The data edges collapse at about 3 to 4 nanoseconds after the negative clock edge. Thus critical data hold time for synchronous clock recording can be determined. The six least significant bits of the clock probe test BCD counter are at pins 2 through 7. Pin 2 corresponds to the LSB, and pin 7 to the MSB (signal at pin 5 of the probe) of the data test probe BCD counter at connector 8.

10. Trigger Output. This connection outputs a TTL signal with its rising edge at trigger time. The trigger output signal stays positive until the logic analyzer is disarmed after the trigger delay.

11. Trace (Recording) output:
    a. Normal Recording. The positive edge of the TTL signal appears at the start of recording. The negative edge occurs at the end of trigger delay.

b. Transition Recording or Data Qualified Recording. During data qualified or transition recording, this signal goes high only when a qualified data word is read into memory. The last negative edge of the signal occurs at the end of trigger delay. (See Section 3.3.2.3).

12. IEEE-488 Interface (Option). IEEE-488 address can be programmed. This is discussed in Section 3.3.3.3.

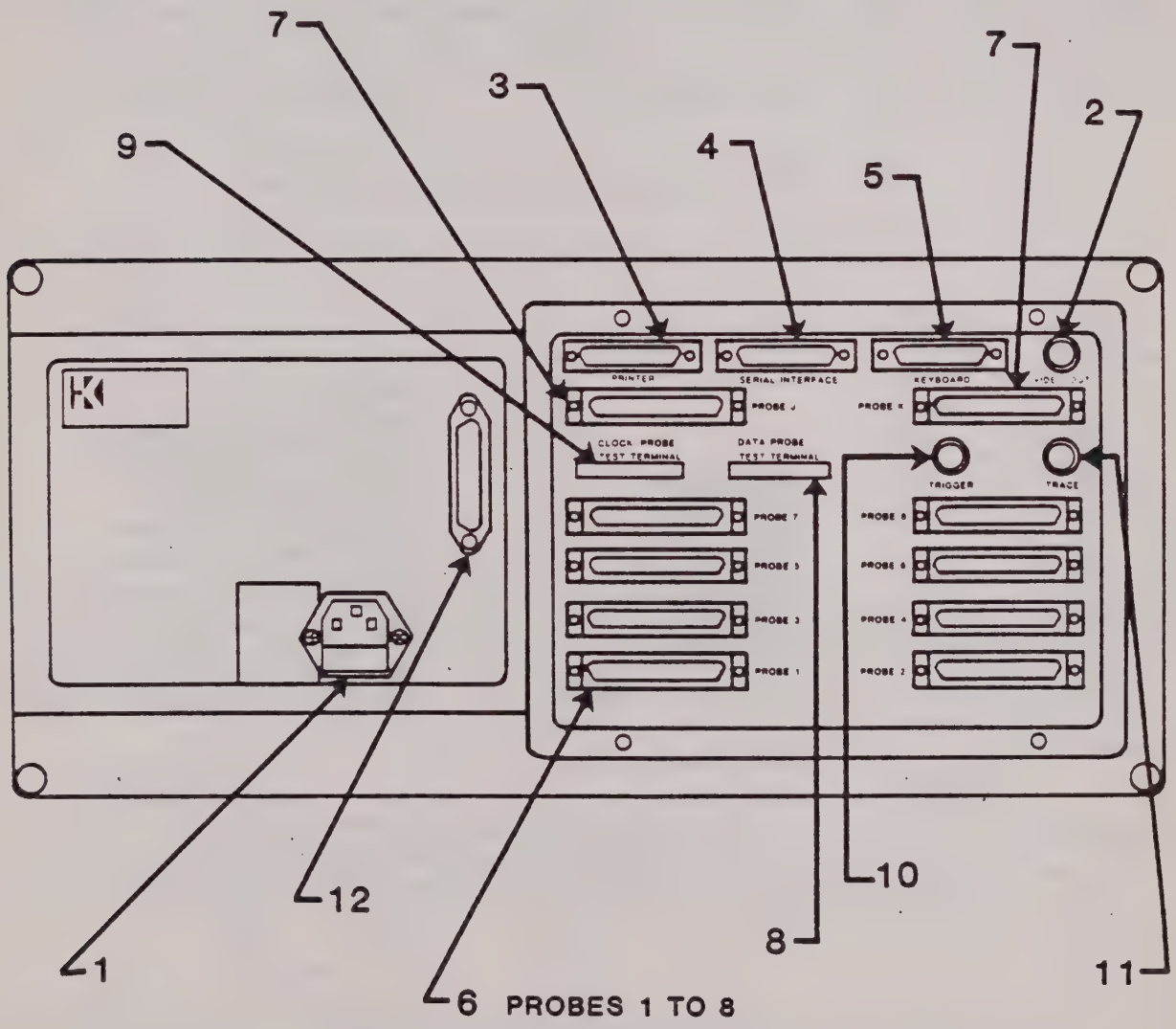


Figure 3-7 Back Panel Connections

3.2.4 PROBE INPUTS

Probes can be connected to the device to be tested either with the color coded connector sets delivered with the KLA, or with other flat cables. The colors on the sets delivered with the KLA correspond to resistor color code. The white ground wire should be connected to the system ground. The clips can be pulled off the connectors, and the ends can be attached to wire wrap posts or on IC clamp adapters via plug adapters.

If a flat cable is to be used, 16-wire flat cable, or a twisted pair of cables is necessary, where there is a ground wire between two signal inputs. The cables should not be too long to avoid circuit capacity and inductivity at higher frequencies. A flat cable equipped with a plug is availabe from Kontron. See **Figure 3-8, Probe Connections.**

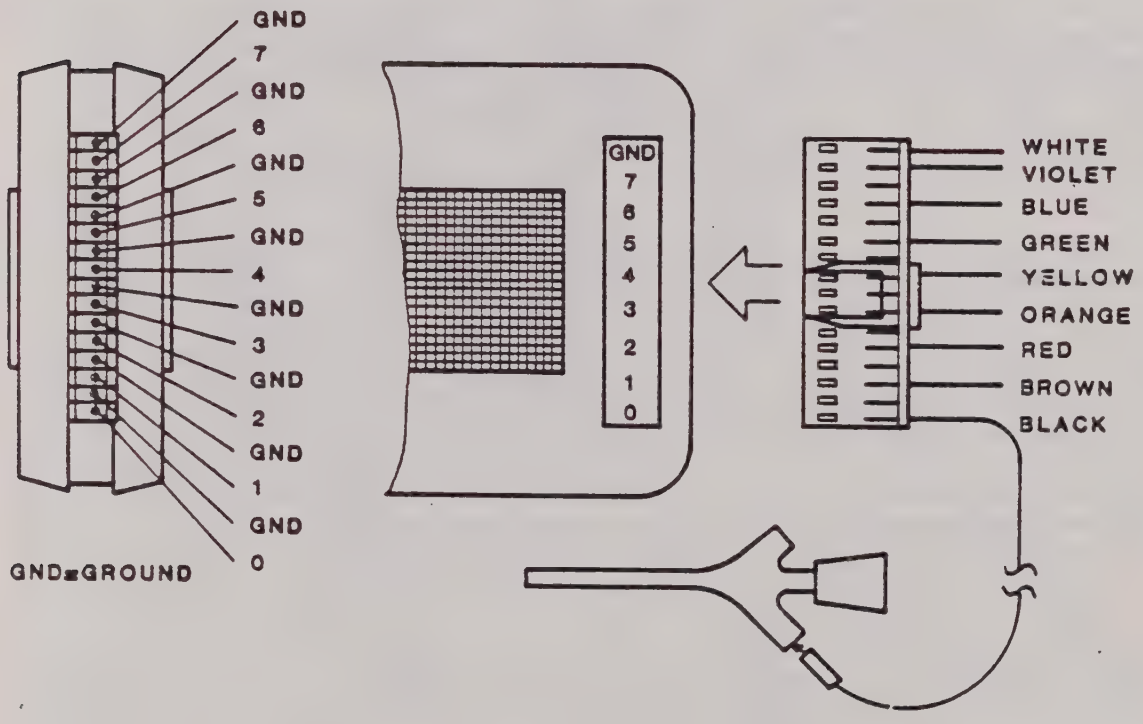


Figure 3-8 Probe Connections

3.3 MENU PROGRAMMING

3.3.1 GENERAL RULES OF MENU PROGRAMMING

KLA is programmed with menus, which give an overview of all the parameters, and demonstrate the capabilities and uses of the device. The parameters are divided logically into two groups, the standard menus and the special menus. The numbers in parenthesis refer to the key identification numbers found on the foldout keyboard drawing **Figure 3-34, KLA Keyboard** found at the end of Chapter 3.

3.3.1.1 Menu Callup Sequence

NOTE: **It is recommended that the user callup these menus in the order listed below and program them in sequence.**

Menus are called up by pressing the ROLL key (1) or STD/SPEC key (2). The two sets of menus are:

1. Standard Menus
   - Configuration Menu
   - Trigger Word Menu
   - Trigger Sequence
2. Special Menus
   - Compare Menu
   - Store/Recall
   - I/O

When the device is turned on, first the transient Status Menu appears and disappears. Next, the Configuration Menu comes up. STD/SPEC key (2) is used to switch between the two sets of menus. Individual menus are selected by holding down the ROLL key (1). If this key is held down, the menus will be displayed in order.

3.3.1.2 Parameter Input

To change a parameter within a menu, the cursor is positioned on the desired parameter field with the UP, DOWN, RIGHT, LEFT cursor movement key group (6).

If the SCREEN mode is being used while in the trigger word or trigger sequence menu, this must be change to FIELD mode by pressing the FIELD key, before parameter selections can be made.

1 Non-numeric parameters: Roll to the desired setting by using the ROLL UP or ROLL DOWN key. (It does not matter which one you use.)

2 Numeric parameters: Numeric parameters are entered via the keyboard. Entries which exceed the limits of the parameter field are automatically corrected to the parameter field limit. Illegal symbols are ignored. The cursor is moved between the parameter fields by using the LEFT, RIGHT cursor movement key set (11).

The newly selected parameters are adopted by the logic analyzer as soon as the cursor leaves the parameter field, or the RUN/STOP key is pressed.

A short index of the permissible parameter inputs or menu possibilities is displayed in the lower half of the screen.

3.3.1.3 Cursor Control

The cursor is moved in the parameter fields by the four movement keys identified as (6). When shifting between menus and submenus, the cursor will note the point of origin and return to the same location. The division into submenus is shown on the displays by means of dotted lines, however the user does not need to know or pay attention to the subdivision lines in order to use the instrument effectively.

3.3.1.4 Incompatibility Between Parameter Settings When Rolling

When rolling through menu options in a parameter field, the user can overwrite settings that are in use at another menu level, because some of the parameters being rolled through are incompatible with earlier settings. In this case, the KLA remembers the earlier settings and restores them when the incompatible setting is rolled through. There are two exceptions which do not get restored when the incompatibility is removed. These are the channel group distribution in the Trigger Word Menu, and trigger words in the Trigger Sequence Menu.

3.3.1.5 Summary of Operation Sequence For Menu Programming

Menu programming sequence discussed in this section is briefly summarized on the next page.

OPERATION SEQUENCE FOR MENU PROGRAMMING

1. Switch on device.
   Put in system disk
   Press system reset button

2. Select menu
   Use STD/SPEC (2), ROLL (1)

3. Position cursor to desired parameter
   Use RIGHT, LEFT, UP, DOWN keys (6)

4. Select parameter input
   Use ROLL UP or ROLL DOWN keys (9) or
   Enter direct input via the alphanumeric keyboard

5. Start recording
   Use RUN/STOP key (20)

6. Evaluation See Section 3.4
   Use TIMING (4), or LIST (5)

3.3.2 STANDARD MENUS

3.3.2.1 Configuration Menu

All parameters for recording, except trigger conditions, are set in this menu. See **Figure 3-9, Sub-Menus In Configuration Menu.**

The parameter fields are identified by callout numbers in **Figure 3-10, Parameter Fields In Configuration Menu,** as listed below:

PARAMETER FIELD	CALLOUT NUMBER IN FIGURE 3-10
a. Memory Configuration	1 and 4
b. Clocks and Clock Qualification	5 and 7
c. Glitch Latching	2
d. Thresholds	3
e. Trigger Position	9
f. Master Clocks	8

Each of these parameter fields (a) through (f) will be discussed in detail now. The input selections available in each of these parameter fields are summarized in **Table 1, Inputs In The Configuration Menu,** located at the end of this Section 3.3.2.1.

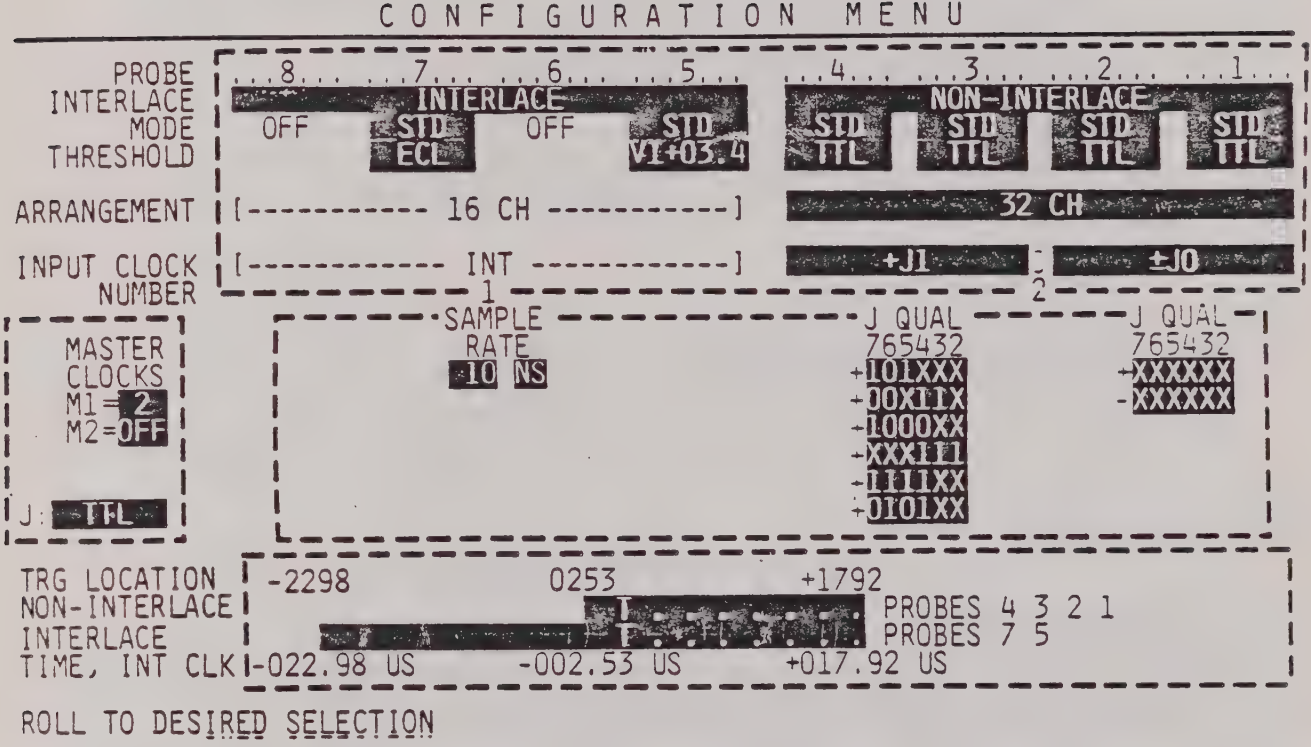


Figure 3-9 Sub-Mènus In Configuration Menu

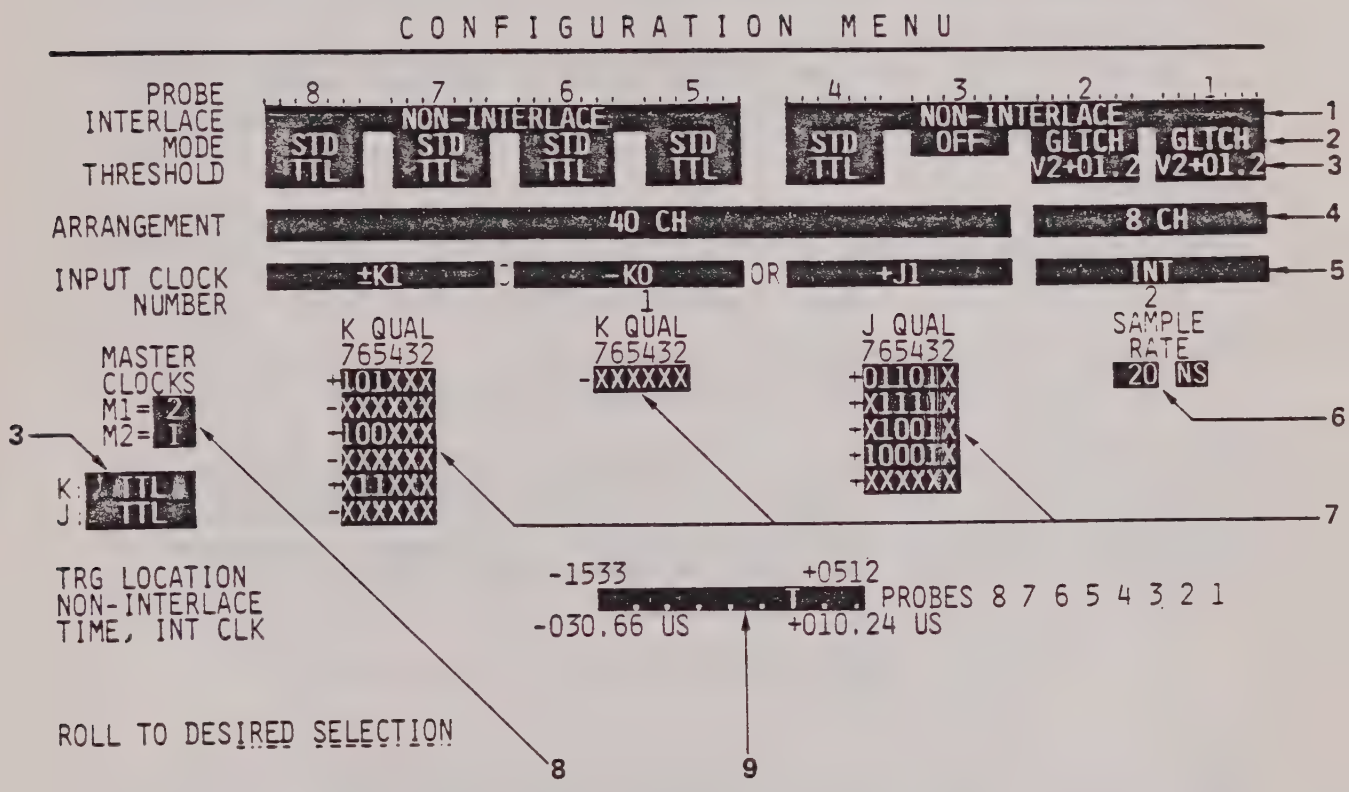


Figure 3-10 Parameter Fields In Configuration Menu

a. Memory Configuration: Interlace and Arrangement

INTERLACE:
The KLA is organized into 16 channel memory blocks in both the hardware and the software. All of the memory blocks can be reconfigured into the interlace mode, where the number of channels is halved, and clock rate and memory depth are doubled. Interlace mode is especially well suited to time domain analysis with the asynchronous internal clock of the KLA which is independent of the system being tested.

For channel groups working together in the interlace mode, recording is possible only with the internal clock of the logic analyzer. Other channels recorded simultaneously in non-interlace mode can only be read in with the external clock.

ARRANGEMENT:
Channel blocks not working in interlace mode can be assigned to a common clock through the OR connection of several clocks.

b. Input Clocks and Clock Qualifiers

1. Input Clocks

When channel groups are combined in ARRANGEMENT, the sampling clock can be internal, external, or a combination of several OR connected external clocks. This OR connection shown as OR or O in the menu, also applies to clock inputs assigned to the probes in arrangement. For example,

Clock Input K1 for Probes 8 and 7
" " K0 for Probes 6 and 5
" " J1 for Probes 4 and 3
" " J0 for Probes 2 and 1

then if the channels of Probes 8 and 7 are combined with channels of probes 6 and 5, these 32 channels are then sampled with clock K1 OR'ed to clock K0.

Sampling is possible with both the positive and the negative edge, or both edges of the sampling clock, or the user can turn off the clock input.

OR connection between external and internal clocks which are asynchronous to each other is not possible, because such OR'ing would not be logical.

The clock rate of the internal clock is set in steps of 1-2-5, in the range of 20 ns up to 500 ms in non-interlace mode, or when in interlace mode from 10 ns up to 500 ms.

2. Clock Qualifiers

For enabling or disabling external clocks, a maximum of 6 OR'ed qualifier words, 6 bits wide during recording with a single clock edge, or 3 OR'ed word pairs during recording with both clock edges are allowed. The 6 bits of each qualifier word indicate the condition (1 = HIGH, 0 = LOW, X = DON'T CARE) that must be detected at each input in order to enable the clock. If the qualifier conditions are not met, a sample will not be taken during that clock edge.

The following holds true for qualifier words:

- Individual bits of a qualifier word are AND connected, and must all be true at the same time.
- Individual qualifier words are OR connected so satisfying the condition of any one word will enable the clock edge. However, if fewer than 6 qualifier words are set, the last word in the column which contains only don't cares will not be valid for qualifying until a 1 or 0 is entered.
- If both edges of an external clock are being used for scanning the positive and the negative edges can qualify independently.
- If one of the words preceded by a + or a - is fulfilled, a sample is made by the corresponding + or - edge.
- The same qualifier inputs are used for qualifying both J clocks, although different qualifier words can be defined. The same holds for both K clocks.

```
K1
     qualified via K2...K7 (probe K pin2...pin7)
K0

J1
     qualified via J2...J7 (probe J pin2...pin7)
J0
```

- Qualification of the internal clock via clock qualification input is not possible, but data selection can be accomplished with DATA QUALIFIED RECORDING (See Section 3.3.2.3.)

c. Glitch Latching

Because glitches which appear asynchronously with the recording clock are not generally caught by that clock, the KLA has a glitch detection circuit. This circuit is activated by selecting the GLITCH mode from the MODE field, identified as 2 in **Figure 3-10, Parameter Fields In Configuration Menu.**

Every other channel of a probe operating in glitch mode is used to detect and store glitches. Channels 1, 3, 5, and 7 are used for glitch memory, and the inputs on these channels are turned off. Glitch latching takes place on pins 0, 2, 4, and 6 of a probe in glitch mode operation. Glitch mode operation is possible only on channels running in non-interlace mode.

The advantages of a glitch detection circuit over the usual glitch latching mode are several:

1. Glitch information cannot be lost in signal information, therefore, glitches appearing directly before or after a signal edge are caught.

2. Glitch detection is possible on channels sampled by an external clock.

3. It is possible to trigger on glitches. However to trigger on glitches effectively, the trigger poll must occur with the master clock sampling these channels.

Glitches can be displayed both on the timing display and the data list. See also Section 3.4.1.1 and 3.4.2.1.

1. **Glitches in the Timing Display:**

a. Glitch Display On The Signal Channels:

In an 8-channel timing display glitches are shown as vertical lines half the height of signal edges. In 16-channel time display glitches appear as shaded areas which remain on the screen when maximum magnification is selected.

b. Direct Display of Glitch Memory Channels:

In 8-channel glitch memory time display, glitches are shown as vertical lines, half the height of the signal edges. In 16-channel time display, glitches are shown as positive pulses on the appropriate lines.

Switching back and forth between the signal channels and glitch memory channels is done by positioning the parameter cursor on the channel number field, then pressing the G key. This is the same whether 8 or 16 channels are being displayed.

2. **Glitches In The Data List Display:**

A glitch appearing on a given channel is represented by a reverse video exclamation point (!), immediately to the right of the appropriate data bit, but only when the data display is in binary format. Therefore, probes on glitch mode must be displayed in binary, if the glitch marker (!) is to show.

d. Threshold

KLA has six available thresholds. These thresholds are:

1.TTL (+1.4V)

2.ECL (-1.3V)

3.V1...V4 (-12.7V...+12.7V in 100 mV increments)

Any one of these can be assigned independently to each of the 10 probes.

e. Trigger Location

The reference point for data recording with a logic analyzer is the trigger, therefore, the trigger location is designated as the reference point for memory addressing in the KLA. The trigger is always at address 0000. Pre-trigger data are in the negative address locations, and post-trigger data are in the positive address locations.

To change the trigger location in memory, the cursor key groups (6 or 11 as shown in **Figure 3-34, Keyboard for KLA**), are used to move the T in the Trigger Location Field in the Configuration Menu. The T can be moved in steps of 256 memory locations from the end of memory, where post-trigger data equals 0, to within 253 bits of the beginning of memory, where the post-trigger data equals 1792 memory places. If the number of samples before finding the trigger condition is smaller than the specified pre-trigger data, then the memory is not entirely filled. In this case the portion before recording starts appears in memory as 0. If necessary insert DELAY in the first trigger level, or use the trigger setting:

"IF ... OCCURS AFTER ... COUNTS, THEN ..."

Single step movement of the trigger location is possible, and is explained under the Trigger Sequence Menu, in Section 3.3.2.3.

In interlace operation, the number of pre-trigger data increases to 2048, but the number of post-trigger data does not change.

f. Master Clocks

The master clock controls the trigger sequence, and selects the point in time for data sampling when preset trigger conditions are fulfilled. The master clock is also responsible for event counting and switching to the next trigger level.

During data recording with two or more clocks, the KLA has the capability of designating any two of the recording clocks as master clocks. These can be selectively assigned to the trigger words, so that during a trigger sequence it is possible to trigger on events recorded with either clock. Efficient triggering is guaranteed only if the clock polling certain data channels agrees with the clock which executes the data search for these channels.

When triggering on words recorded with various clocks which are synchronous to one another, the use of several master clocks is unnecessary.

If two master clocks are needed, the selected master clock is assigned in the Trigger Words Menu before a trigger word is input. See **Section 3.3.2.2 Trigger Words Menu.**

Table 1 Inputs In The Configuration Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	INTERLACE	See Glossary	BOTH NON-INTERLACE INTERLACE/NON-INTERLACE BOTH INTERLACE	ROLL
2	MODE	Valid for Individual Probes	STANDARD GLITCH LATCHING[1] OFF	ROLL
3	THRESHOLD	Valid for Individual Probes	TTL ECL V1 to V4 0 to ± 12.7V	ROLL +,- 0 to 9
4	ARRANGEMENT	Division into logical channel groups	64 channels[2] 48/16 32/32 32/16/16 16/16/16/16	 ROLL
5	INPUT CLOCK[3]	Pre-selection of Clock[4]	Probes 8,7: INT., K1,OFF[5] Probes 6,5: INT., K0,OFF Probes 4,3: INT., J1,OFF Probes 2,1: INT., J0,OFF	ROLL
6	SAMPLE RATE	Sample Rate of Internal Clock	Non-Interlace: 20 ns - 500ms Interlace: 10 ns to 500 ms	ROLL
7	K QUAL	Clock Qualifier for Probes 5,6,7,8	0,1,X	0,1,X
	J QUAL	Clock Qualifier for Probes 1,2,3,4	0,1,X	0.1.X
8	MASTER CLOCKS	See Glossary	OFF, 1...4[6]	ROLL
9	TRIGGER LOCATION	Trigger Position	8 Positions	key (3)

NOTES TO TABLE 1:

1 Glitch latching is possible only on channels in non-interlace operation, when the sample clock for the channels is M1.

2 During glitch operation channel numbers decrease by half, or when individual pods are switched off, the channel numbers listed decrease accordingly.

3 OR connection between external and internal clock is not possible. Otherwise, clock inputs are OR'ed for channels grouped together in arrangement.

4 With external clock, data can be captured on the rising, falling or both edges for the clock.

5 K1 = clock probe K, pin 1; K0 = clock probe K, pin 0 etc.

6 Master Clock M1 is the clock connected to Probe 1 and 2 (J0 or INT).

3.3.2.2 TRIGGER WORDS MENU

Trigger words, data qualifying words, and the format of the data list are set in the Trigger Words Menu. See **Figure 3-11, Sub-Menus In Trigger Menu.** The parameter fields are identified by callout numbers in **Figure 3-12, Parameter Fields in Trigger Words Menu,** as listed below:

PARAMETER FIELD	CALLOUT NUMBER IN FIGURE 3-12
a. Distribution into Channel Groups	1
b. Data Format and Polarity	2 and 3
c. Mnemonics	4
d. Master Clock Assignment	5
e. Trigger Words	6

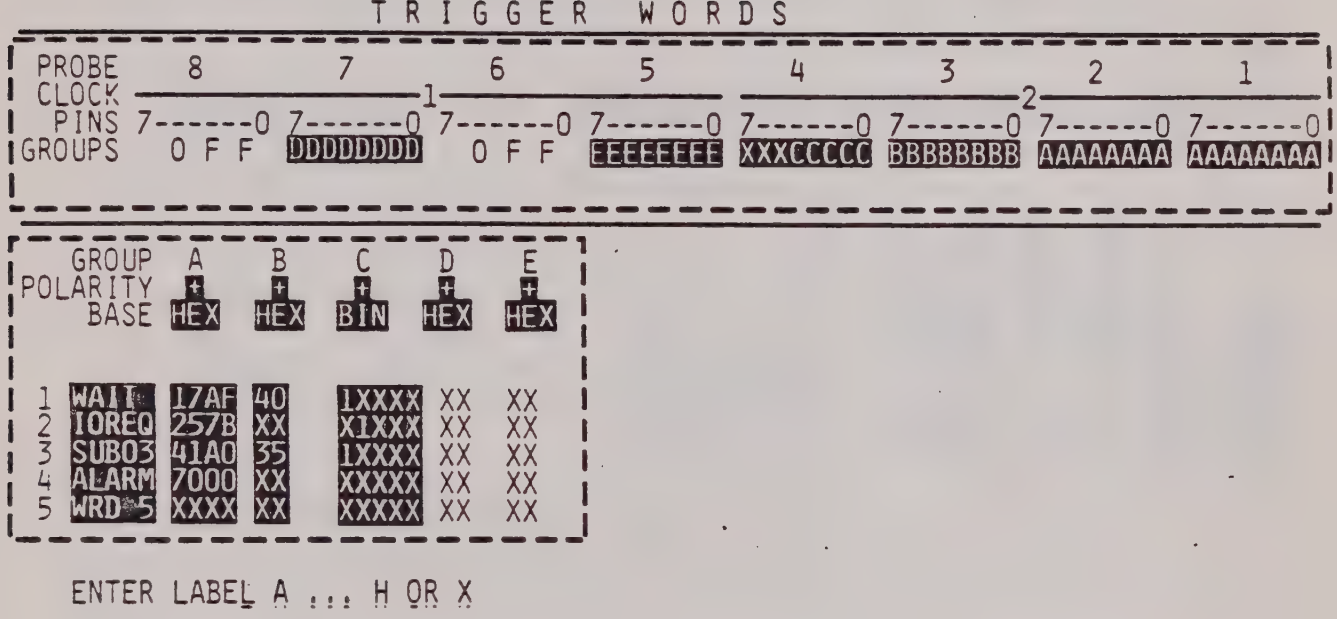
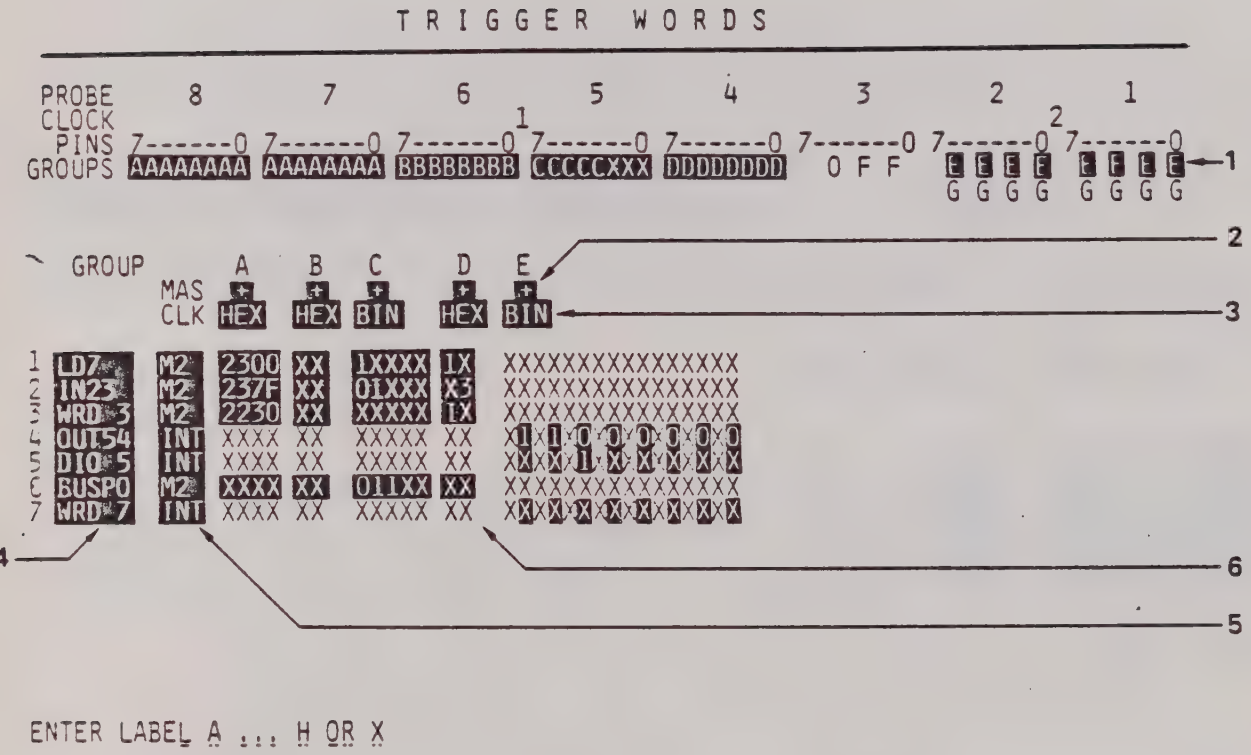

TRIGGER WORDS
PROBE 8 7 6 5 4 3 2 1
CLOCK 1 2
PINS 7------0 7------0 7------0 7------0 7------0 7------0 7------0 7------0
GROUPS 0 F F DDDDDDDD 0 F F EEEEEEEE XXXCCCCC BBBBBBBB AAAAAAAA AAAAAAAA
GROUP A B C D E
POLARITY + + + + +
BASE HEX HEX BIN HEX HEX
1 WAIT 17AF 40 1XXXX XX XX
2 IOREQ 257B XX X1XXX XX XX
3 SUB03 41A0 35 1XXXX XX XX
4 ALARM 7000 XX XXXXX XX XX
5 WRD 5 XXXX XX XXXXX XX XX
ENTER LABEL A ... H OR X

Figure 3-11 Sub-Menus In The Trigger Word Menu


TRIGGER WORDS
PROBE 8 7 6 5 4 3 2 1
CLOCK 1 2
PINS 7------0 7------0 7------0 7------0 7------0 7------0 7------0 7------0
GROUPS AAAAAAAA AAAAAAAA BBBBBBBB CCCCCXXX DDDDDDDD 0 F F EEEE EEEE
GGGG GGGG
1
2
GROUP A B C D E
MAS
CLK HEX HEX BIN HEX BIN
3
1 LD7 M2 2300 XX 1XXXX 1X XXXXXXXXXXXXXXX
2 IN23 M2 237F XX 01XXX X3 XXXXXXXXXXXXXXX
3 WRD 3 M2 2230 XX XXXXX 1X XXXXXXXXXXXXXXX
4 OUT54 INT XXXX XX XXXXX XX X1 1 0 0 0 0 0 0
5 DIO 5 INT XXXX XX XXXXX XX XX X 1 X X X X X
6 BUSPO M2 XXXX XX 011XX XX XXXXXXXXXXXXXXX
7 WRD 7 INT XXXX XX XXXXX XX XX X X X X X X X X
4
6
5

ENTER LABEL A ... H OR X

Figure 3-12 Parameter Fields In The Trigger Word Menu

a. Distribution Into Channel Groups

The inputs of the KLA are divided into 8-channel groups corresponding to the pods. They can be further divided into groupings of adjacent inputs by entering the same letter (A through H or X in the parameter field identified as 1 in **Figure 3-12, Parameter Fields In The Trigger Words Menu.**

In entering letters into parameter field 1 the following rules must be observed:

1. A letter can be used only in one coherent group.

2. A coherent group can extend over a maximum of 16 inputs.

3. Inputs that are sampled with separate clocks must be defined as separate groups.

4. No letter can be designated for groups which have been set at OFF in the Configuration Menu.

5. Entering the letter X causes a "don't care" condition at that position for all trigger words.

6. Entering a "don't care" at the appropriate position deletes that channel from all trigger words and from the data list.

Points 3 and 4 above point out the fact that there is an interaction between menus. Also, modification of clock and channels, as happens for example, when glitch mode operation is selected, can partially erase a selected channel grouping. If planning to make extensive programming changes, check and regroup the channels where necessary. Channels where glitch mode recording is selected are identified on the line, under the channel group division of the Trigger Word Menu, with the subscript "G".

Channel group distributions selected in the Trigger Word Menu are also valid for Compare Menu, and the data list display.

b. Polarity And Data Format

In **Figure 3-12, Parameter Fields In The Trigger Words Menu**, field 2 identifies the parameter field where the polarity for the trigger word input can be changed. If inverted data is present at the signal inputs, the recommended polarity choice is minus, so that trigger words do not have to be entered in inverted form.

In field 3, in the same Figure 3-12, the data format for inputting trigger words is selected. ASCII, and EBCDIC formats cannot be used for entry. However, they can be called up on the data list and displayed.

In both fields 2 and 3, the DELETE key (18) causes a "don't care" condition in the group of trigger words or column.

Table 2 Inputs In The Trigger Word Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	Groups	Channel group distribution	Related groups of the same letters[1]	A...H,X
2	Polarity	Polarity of Trigger Word Input	+,-	ROLL
3	Base	Data Format of Trigger Word Input	BIN, HEX, DEC, OCT	ROLL
4	---	Mnemonics for Trigger Words	Any name, first symbol must be a letter	A...Z 0...9
4	MAS CLK	Master Clock Assignment	M1, M2, Select Any One Or Both	ROLL
6	---	Trigger Words:[2]		
		BIN	0, 1, X	0, 1, X
		HEX	0...F, X	0...F, X
		DEC	0...9, X	0...9, X
		OCT	0...7, X	0...7, X

NOTES TO TABLE 2:

1 Maximum group width is 16 channels, separate groups for channels with different sampling clocks. A given letter may be used only in one group. X is permissible in any group.

2 Highest value bit is on the left side of a group. If the channel number of a group is unequal to a whole number multiple of the bits necessary for a symbol, then the bits no longer contained in the character are ignored, that is, treated as 0.

c. Mnemonics

Mnemonics can be assigned to preset trigger words so that trigger words can be called up where necessary in a menu, by entering the mnemonic. These mnemonics must be limited to five characters, begin with a letter, but can contain numbers in the other four places. The DELETE key causes a "don't care" condition of that trigger word in parameter field 4.

d. Master Clock Assignment

These parameter input fields identified as 5 in **Figure 3-12**, appear only when more than one master clock has been selected from the Configuration Menu. A trigger word is assigned a master clock in the Trigger Words Menu. Callup of that trigger word in the Trigger Sequence Menu (discussed in the section immediately following this one), automatically selects the assigned master clock for that trigger level.

Certain triggering limitations are placed on the trigger word menu, under the following conditions:

1. Recording with several synchronous clocks:
   All channels can be triggered with one master clock. If internal and external clocks are recording simultaneously, synchronous operation cannot be assumed, and different master clocks must be assigned.

2. Recording with several asynchronous clocks:
   Simultaneous triggering on all channels is not allowed. In order to trigger on different trigger levels on channels sampled asynchronously, both clocks must be defined as master clocks.

Trigger word input is only possible for channel groups when the recording clock of the trigger word is also the master clock for that channel group.

e. Trigger Words

Trigger words are entered in Field 6 in **Figure 3-12, Parameter Fields In The Trigger Word Menu.** Up to 32 trigger words can be defined. If a numeric value is used in one trigger word, the next trigger word space will automatically get the next higher numeric value. The screen shows 11 trigger words at a time. In order to scroll through all the trigger words that are input, press the SCREEN key (8), then UP, or DOWN key from key group (6).

3.3.2.3 TRIGGER SEQUENCE MENU

KLA can trigger on individual words, and also up to 14 levels of sequential trigger words, where the actual triggering occurs after the last word in the sequence is found. The sequence is preset in the trigger level. In every trigger level, only one word, or two words with an OR connection can be searched. The number of times a word has to be found to satisfy the trigger condition is also user defined. Trigger levels do not have to be executed in any order; jump instructions can be given, and the KLA will jump to noncontiguous trigger levels. Also, time frames can be assigned to trigger words where the time window can be limited on one or both sides. Thus there are two basic types of trigger levels:

1. **TRIGGER LEVEL WITH TRIGGER WORD SEARCH IN A TIME FRAME LIMITED ON BOTH SIDES**

WORD BEING SEARCHED	SEARCH TIME WINDOW	INSTRUCTION IF FOUND	,	INSTRUCTION IF NOT FOUND

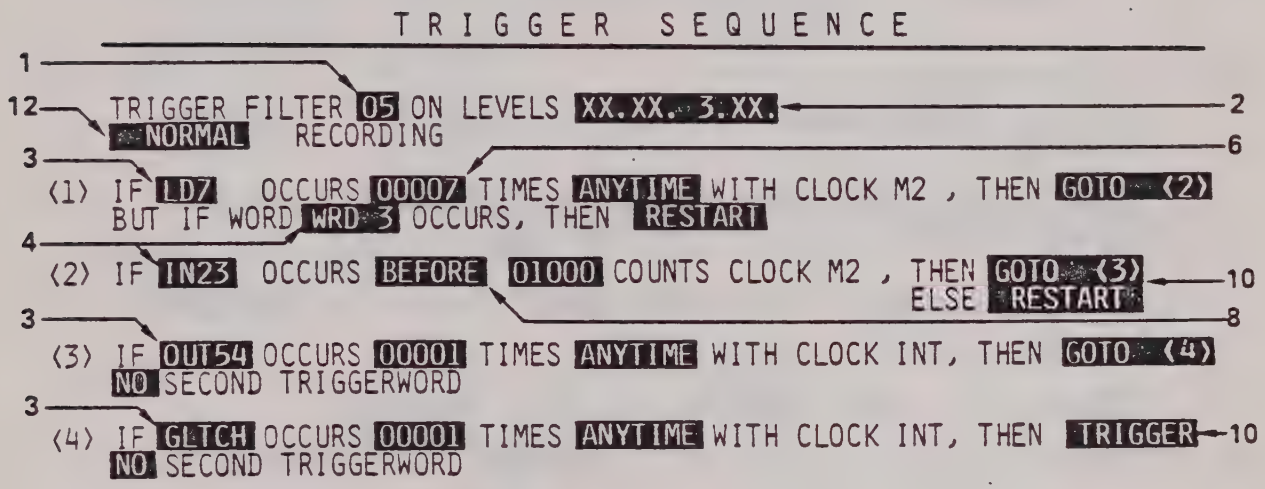
2. **TRIGGER LEVEL WITH TRIGGER WORD SEARCH IN A TIME FRAME NOT LIMITED ON BOTH SIDES**

FIRST WORD BEING SEARCHED and optionally:	EVENT COUNTER	SEARCH TIME WINDOW (not limited)	INSTRUCTION FOR FINDING FIRST WORD

SECOND WORD BEING SEARCHED	INSTRUCTION FOR FINDING SECOND WORD

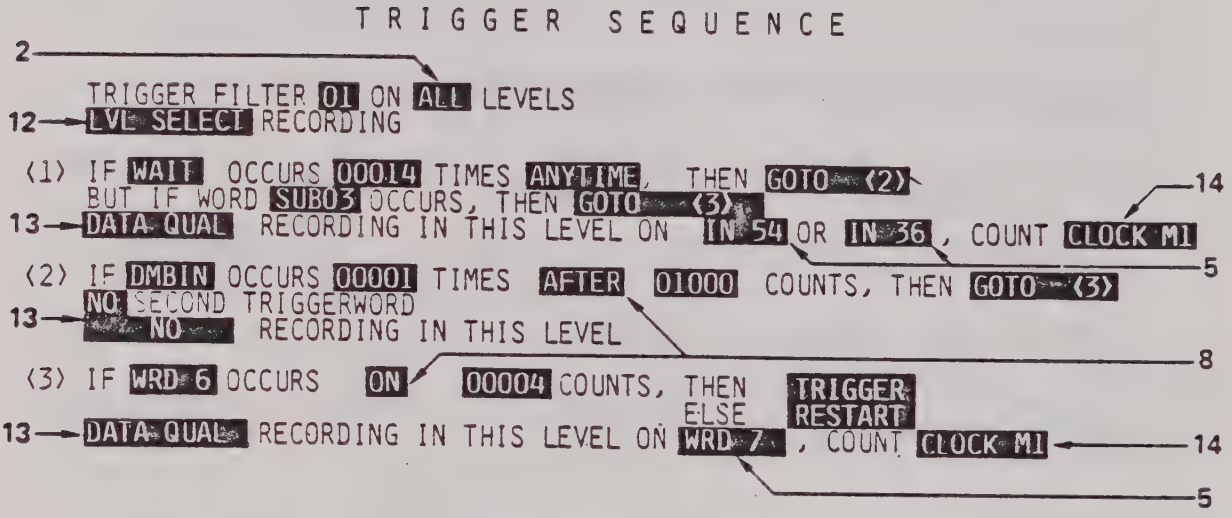
The parameter fields of the Trigger Sequence Menu are identified in the following three figures: **Figure 3-13, Parameter Fields In The Trigger Sequence Menu—Normal Recording, Figure 3-14, Parameter Fields In The Trigger Sequence Menu—Data Qualified Recording,** and **Figure 3-15, Parameter Fields In The Trigger Sequence Menu—Transition Recording.** The functions controlled in the parameter fields identified by callout numbers are listed below.

FUNCTION	PARAMETER FIELD NUMBER	FIGURE NUMBER
a. Trigger filter	1 and 2	3-13, 3-14
b. Trigger word callup	3 and 4	3-13, 3-15
c. Glitch Triggering	3 in level <4>	3-13
d. Event Counter	6	3-13
e. Delay Counter	7	3-18
f. Time Window for Trigger Word	8 and 9	3-13, 3-15
g. Instructions	10	3-13
h. Poll of Second Trigger Word	11	3-13
i. Recording Process	12 and 13	3-13, 3-15
j. Data Qualifying Words	5	3-14
k. Time Measurement/clock counting	14	3-14, 3-15
l. Probe Selection for Transition check	15	3-15


TRIGGER SEQUENCE
1
12
2
3
6
4
10
3
8
3
10
TRIGGER FILTER 05 ON LEVELS XX.XX. 3.XX.
NORMAL RECORDING
(1) IF LD7 OCCURS 00007 TIMES ANYTIME WITH CLOCK M2 , THEN GOTO (2)
BUT IF WORD WRD 3 OCCURS, THEN RESTART
(2) IF IN23 OCCURS BEFORE 01000 COUNTS CLOCK M2 , THEN GOTO (3)
ELSE RESTART
(3) IF OUT54 OCCURS 00001 TIMES ANYTIME WITH CLOCK INT, THEN GOTO (4)
NO SECOND TRIGGERWORD
(4) IF GLTCH OCCURS 00001 TIMES ANYTIME WITH CLOCK INT, THEN TRIGGER
NO SECOND TRIGGERWORD

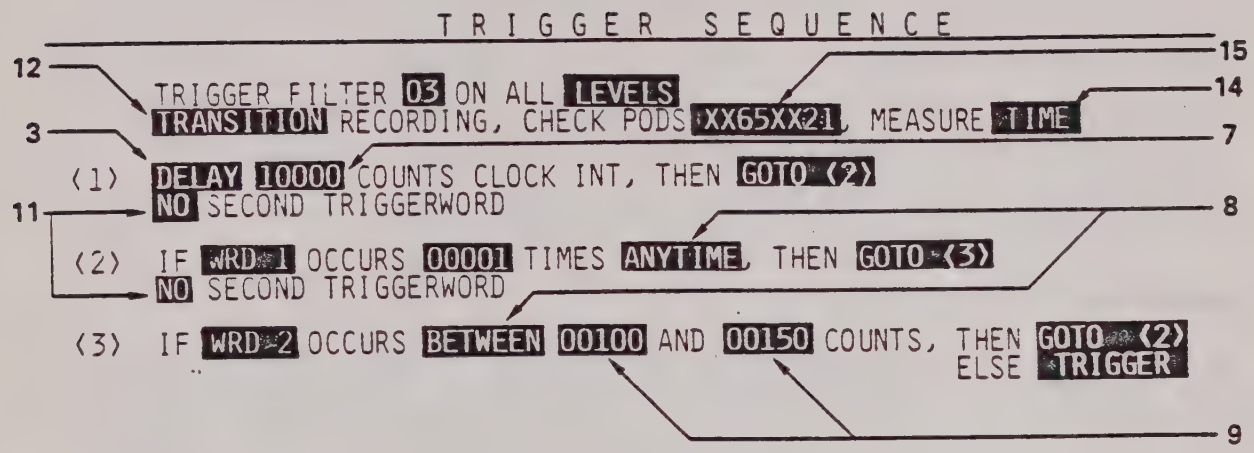
ENTER TRIGGERWORD NUMBER OR MNEMONIC OR ROLL UP/DOWN

Figure 3-13 Parameter Fields In Trigger Sequence Menu
Normal Recording—Glitch Triggering


TRIGGER SEQUENCE
2
TRIGGER FILTER 01 ON ALL LEVELS
12
LVL SELECT RECORDING
(1) IF WAIT OCCURS 00014 TIMES ANYTIME, THEN GOTO (2)
BUT IF WORD SUB03 OCCURS, THEN GOTO (3)
13
DATA QUAL RECORDING IN THIS LEVEL ON IN 54 OR IN 36, COUNT CLOCK M1
14
5
(2) IF DMBIN OCCURS 00001 TIMES AFTER 01000 COUNTS, THEN GOTO (3)
NO SECOND TRIGGERWORD
13
NO RECORDING IN THIS LEVEL
8
(3) IF WRD 6 OCCURS ON 00004 COUNTS, THEN TRIGGER RESTART
ELSE
13
DATA QUAL RECORDING IN THIS LEVEL ON WRD 7, COUNT CLOCK M1
14
5

ENTER TRIGGERWORD NUMBER OR MNEMONIC OR ROLL UP/DOWN

Figure 3-14 Parameter Fields In Trigger Sequence Menu Data Qualified Recording In Individual Trigger Levels



ENTER TRIGGERWORD NUMBER OR MNEMONIC OR ROLL UP/DOWN

Figure 3-15 Parameter Fields In The Trigger Sequence Menu Transition Recording

NOTE: Parameter field 3 is always the first trigger word in trigger levels with the search window ANYTIME or AFTER n COUNTS (Switch on DELAY or GLITCH).

Input and Indication of Trigger Words Not Displayed:

As long as no entry is made in a trigger level, the screen will show only trigger level <1>. Trigger levels 2 through 14 can be called up with a GOTO command, or they can be scrolled through using UP and DOWN cursor movement keys (6), after pressing the SCREEN mode key (8).

Resetting The Trigger Levels

The DELETE key (18) sets the trigger level where the cursor is back to basic position, that is, at trigger level <1>.

```
IF XXXXX OCCURS 00001 TIMES ANYTIME, THEN TRIGGER
NO SECOND TRIGGER WORD
```

End Recording With RUN/STOP Key

If the user interrupts a recording (trigger search or delay not concluded) with the RUN/STOP key, the trigger position appears at the end of memory as address 0000.

Free Run Setting

```
DELAY 05000 COUNTS, THEN TRIGGER (Delay greater than number of pretrigger
data)
NO SECOND TRIGGERWORD
```

The number of pretrigger memory places should be less than the number of samples before finding the trigger. Depending on the pretrigger delay specified on the Configuration Menu, the KLA will capture pretrigger data up to that specified value. However, if triggering occurs before that count, not all the pretrigger data display area will be filled. If a definite amount of pretrigger delay is necessary, then specify that count in the delay setting in the first trigger level.Since the KLA immediately begins trigger search during a recording, the whole memory is not filled with data. The portion before the recording starts appears as zeros. (See also Section 3.3.2.1 e).

The input selections available in each of the parameter fields is summarized in **Table 3 Inputs In The Trigger Sequence Menu.**

Table 3. Inputs In The Trigger Sequence Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	Trigger Filter	See Glossary	01...15 [1]	0...9
2	On Levels...	Validity for Trigger levels...	All 1 2 3 ...a[2]	ROLL
3 to 5		Trigger wrd callup Delay Glitch Trigger	WRD 1...32 all mnemonics Delay in Field 3 GLTCH in Field 3[3]	0...9 A-Z, 0-9 ROLL ROLL
4			NO SECOND TRG WRD	or ROLL
6	...TIMES	event counter[4]	00001...65535	0...9
7	DELAY...COUNTS	Delay counter when field 3=delay	00001...65535	0...9
8		Time Window for Trigger Word Search	ANYTIME AFTER m COUNTS BEFORE m COUNTS ON m COUNTS BETWEEN m AND n Counts	ROLL
9		Time Window Limits[5]	00001...65535	0...9
10		Instructions	GOTO <1> GOTO <a>[2] RESTART, TRIGGER	ROLL
11		Poll of Second Trigger Word[4]	NO SECOND TRG WRD BUT IF ...OCCURS...	ROLL
12 13	Recording	recording process	NORMAL RECORDING DATA QUAL. RECORDING[6] TRANSITION RECORDING LEVEL SELECT RECORDING NO RECORDING (Field 13 only)	ROLL
14		Time Measurement/ Clock Counting	MEASURE TIME COUNT CLOCK M1	ROLL
15		Transition Check	8...X...1	1...8,X

NOTES TO TABLE 3:

1 Maximum value can decrease depending on the settings in fields 8 and 9

2 Where a = highest usable trigger level depending on settings in fields 8 and 10

3 Only with GLTCH in field 2 in the Configuration Menu

4 Possible only if field 8 = "ANYTIME" or "AFTER m COUNTS"

5 With "BETWEEN m AND n COUNTS", n < m is also valid.

6 TRANSITION RECORDING and DATA QUALIFIED RECORDING are not possible when two master clocks are used, or in interlace or glitch mode.

a. The Trigger Filter

During recording with an asynchronous clock (the internal clock of the logic analyzer) system transitions, or glitches may happen to fulfill the triggering conditions. It is generally not desirable to have invalid conditions trigger, unless glitch triggering has been specifically selected. To prevent such transient signals from recording, the KLA has a built-in trigger filter which performs the following two functions:

1. A trigger word is counted as found only if the corresponding data is valid for at least n clocks (n = 1...15).

2. A trigger word is counted as an event, when the event counter has been set, if it does not appear during at least one clock cycle.

The value of the trigger filter is always set in relationship to the duration of an event, or the rate of the recording clock. When the use of the trigger filter on all levels is not desirable, the use of the trigger filter can be limited to specific data inputs. This is true when events are recorded with different master clocks at different trigger levels.

The trigger filter is limited by rolling to ON LEVELS setting in parameter field 2 in the Trigger Sequence Menu. The numbers of the active trigger levels appear in an input line; if "X" is entered, the trigger level is switched off for that level.

The maximum value for the trigger filter is limited by the time windows (Parameter Fields 8 and 9) which are set for all trigger levels for which the trigger filter is valid. For example:

BEFORE m COUNTS maximum value = m
BETWEEN m and n COUNTS maximum value = n-m
ON m COUNTS maximum value = 1

The KLA corrects a larger value during input, or when boundaries of n or m are changed. Once set the trigger filter value stays valid as long as the cursor does not go past field 1 of as long as a recording is not started.

The minimum value for the trigger filter is equal to 2 for TRANSITION RECORDING, or when the internal asynchronous clock is used with rate of 10 ns in interlace, or 20 ns in non-interlace.

b. Trigger Word Callup

Words set in the Trigger Word Menu can be called up at three locations in the Trigger Sequence Menu.

1 To poll the first trigger word in a trigger level

2. To poll a second trigger word in the same trigger level

3. As qualifier words for DATA QUALIFIED RECORDING

The pre-programmed trigger word is called up by inputting either the number of the trigger word, or the mnemonic from the Trigger Word Menu. When the trigger word is called up by the number, the corresponding mnenomic will appear on the screen. If no mnemonic has been assigned, the default mnemonic WRD 1...WRD 32 appears.

Two different trigger words with different master clocks cannot be used in a single trigger level.

c. Glitch Trigger (GLTCH)

First, glitch mode has to be selected in the Configuration Menu. Then parameter field 3 in Trigger Sequence Menu can be set with the ROLL key (9) to GLTCH. This results in a search for glitches on channels running in glitch mode in that trigger level. The trigger word GLTCH is considered found, when a glitch appears on one or several of the active inputs of the probe (0,2,4,6) which is switched to glitch recording.

d. Event Counter

The event counter indicates how often the word searched for in this level must be found to fulfill the trigger condition. It is set in parameter field 6 of the Trigger Sequence Menu. This event counter can be thought of as a loop counter, that is, it will count the number of times a program loop is run through, and will only free the next trigger condition when the preset number has been run through.

If the trigger filter has been turned on, the event counter will count the word as found again, only when it is not detected for at least one clock cycle after the last time it was found. This is done with a suitable external clock which scans every data word.

If the trigger filter is off (00), every clock cycle where the word occurs is counted as found. A word which occurs in several successive clock cycles is counted as found in each cycle.

e. Delay Counter

Trigger delay can be chosen in field 3 (Figure 3-15) by the roll key (9), and the length of the trigger delay is set in field 7 in units of the recording clock. During the delay period, no trigger word is searched unless a second trigger word has been defined and a BUT IF ... OCCURS ... condition is met, at which time a special instruction written for exactly this situation will execute.

Presetting a trigger delay is especially useful in cases where most of the data being analyzed occurs a long time interval after the trigger point. When the trigger delay chosen is large, the time window to be analyzed contains mostly post-trigger events.

f. Time Window For Trigger Word Search

The time window settings are shown in **Figure 3-15, Parameter Fields In The Trigger Sequence Menu.** These settings define the time frame in which the word should appear after callup of a given trigger level. Available settings for these parameter fields are:

ANYTIME	Search begins immediately and continues as desired.
BEFORE m COUNTS	Search begins immediately and ends with the mth count.
AFTER m COUNTS	Search begins after m counts and continues as desired.
BETWEEN m AND n COUNTS	Search begins with the mth count and ends with the nth.
ON m COUNTS	Search takes place only during mth count.

BEFORE..., AFTER..., BETWEEN... define the boundaries of the time window in terms of m and n.

Trigger word search is limited to the area inside a time window. This time search window is set by the user. Parallel polling of a second word occurs if the condition BUT IF...OCCURS..., happens on the same trigger level with AFTER m COUNTS in which case the second word will be polled during the mth count.

Time windows are especially useful in the following cases:

1. When the same word sequence occurs in several locations in a program, however, only one of these is the desired trigger location.

2. When the actual point in time occurrence of critical signals is the trigger condition; for example, when triggering should occur if a signal is late or early.

Limits For Recording With External Clock With Less Than 35 ns Rate

Since switching between trigger levels takes about 35 nanoseconds, no trigger word can be searched during this interval. When clock frequencies are less than 28 MHz, a setting of ON 00001 COUNTS is meaningless.

A reasonable ratio between the clock rate and the maximum signal frequency is about 1 to 10. This means that with a 50 MHz clock, there would be more that 35 nanoseconds between events. For the boundaries, a value smaller than 4 counts for 100 MHz, or smaller than 2 counts for 50 MHz does not make sense. Likewise, for BETWEEN m AND n, the difference between m and n should not be set smaller than 4 with 100 MHz, and not smaller than 2 with 50 MHz.

g. Factors Influencing The Number Of Available Trigger Levels

The number of available trigger levels depends on the selections made in time windows and other instructions in each trigger level. This complex interaction is briefly summarized here.

1. The maximum number of trigger levels is 14, and these are always available when the time search window is set at ANYTIME. Setting DELAY also does not limit the number of available trigger levels.

2. When a search time window is set in a given trigger level, the number of available trigger levels is reduced by:

   a. Zero level for ANYTIME without jumping and DELAY with jumping.

   b. One level for ANYTIME with jumping, for DELAY with jumping, and for BEFORE m COUNTS and AFTER m COUNTS without jumping.

3. The number of available trigger levels is reduced one more level by jump or trigger commands:

   a. If the first instruction in a level with ANYTIME or AFTER m COUNTS is a jump or trigger command.

   b. If the instruction ELSE... executes a jump or triggering in a level with BEFORE m COUNTS, BETWEEN m AND n COUNTS or ON m COUNTS.

This is not the case when triggering instruction occurs because the trigger conditions have been met, or a jump to the next trigger level happens because the first trigger level has been fulfilled. In these cases, there is no reduction in the trigger level availability.

h. Polling A Second Trigger Word

Two trigger words can be used in an open time window with ANYTIME, or AFTER m CLOCKS setting where the second trigger word can be used as a jump instruction, or an interrupt for an event which should not occur in that program segment. If the second trigger word should occur before the first one is found, the second trigger word will execute.

If the same instruction is given for both the first and the second trigger word, then they will be OR'ed together, and finding one trigger word will fulfill the trigger condition.

i. Recording Processes

Since the recording process is individually set for different trigger levels, the recording inputs are done in the Trigger Sequence Menu. There are four different recording options. These are Normal Recording, Data Qualified Recording, Transition Recording, and No Recording.

1. **NORMAL RECORDING.** Every data word caught by the selected clock edge is recorded.

2. **DATA QUALIFIED RECORDING.** Only the data words which agree with all bits of preset qualifier words are recorded. The qualifier words are set in the Trigger Words Menu, and can contain "X=don't care" for bits which need not be checked in the corresponding data words. When using data qualified recording the user may enter, one or two qualifier words. However, agreement with one of the two qualifier words is sufficient to qualify the data word. Data qualified recording is not possible when two master clocks have been selected in the Configuration Menu. It is also not possible when in the Clitch or Interlace Mode. In Data Qualfied recording the master clock is automatically the clock belonging to Probe 1 and 2, (clock J0).

   Maximum clock rate for Data Qualified Recording is 25 MHz.

   A triggerword which occupies memory location 0000 may be off by one to two memory spaces, if the first and second data words following the triggerword are not stored because they do not match the qualifier word. A triggerword position correction cannot be made because these data words are not stored. See **Figure 3-16, Data Qualified Recording Timing Diagram.**

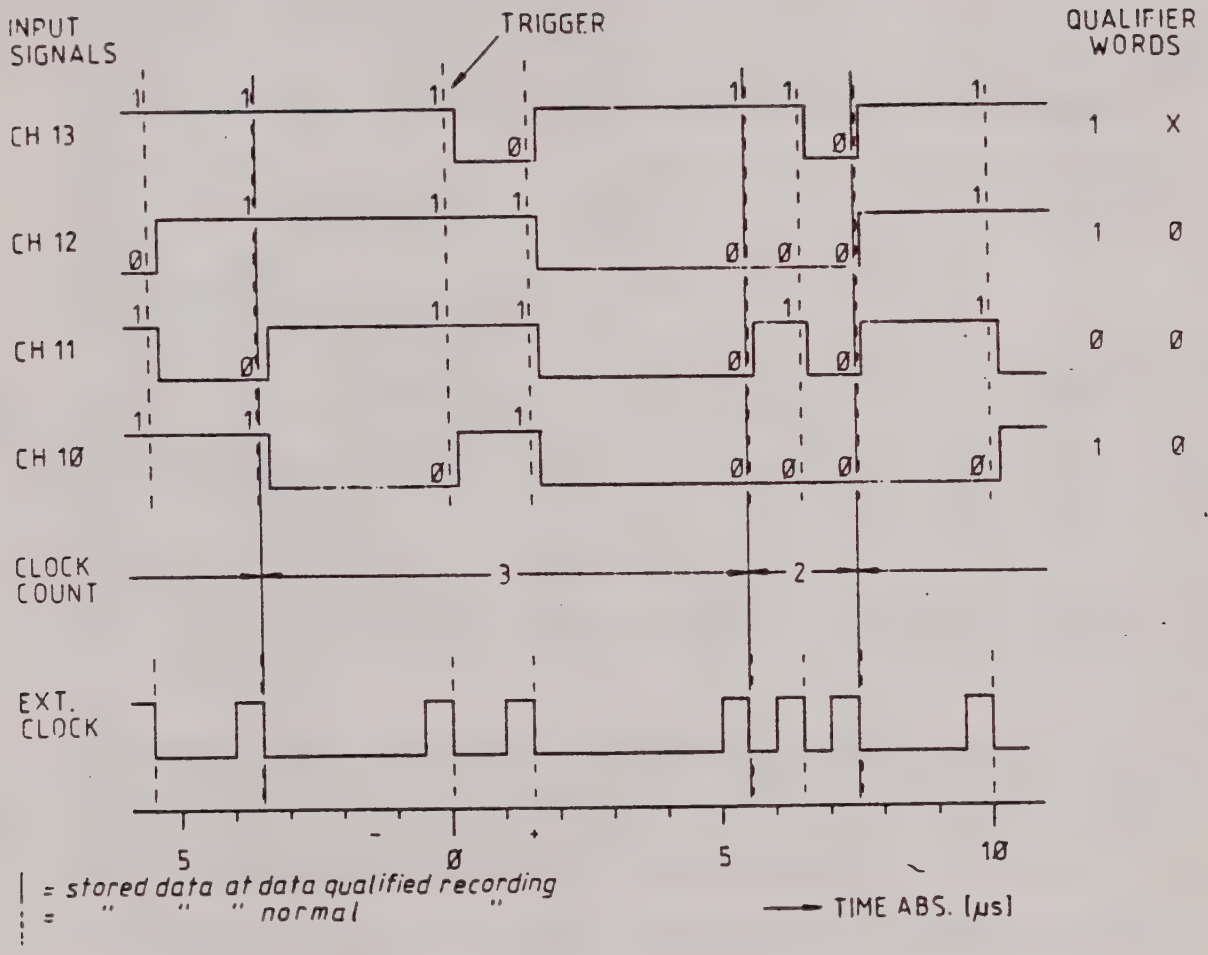


Figure 3-16 Data Qualified Recording Timing Diagram

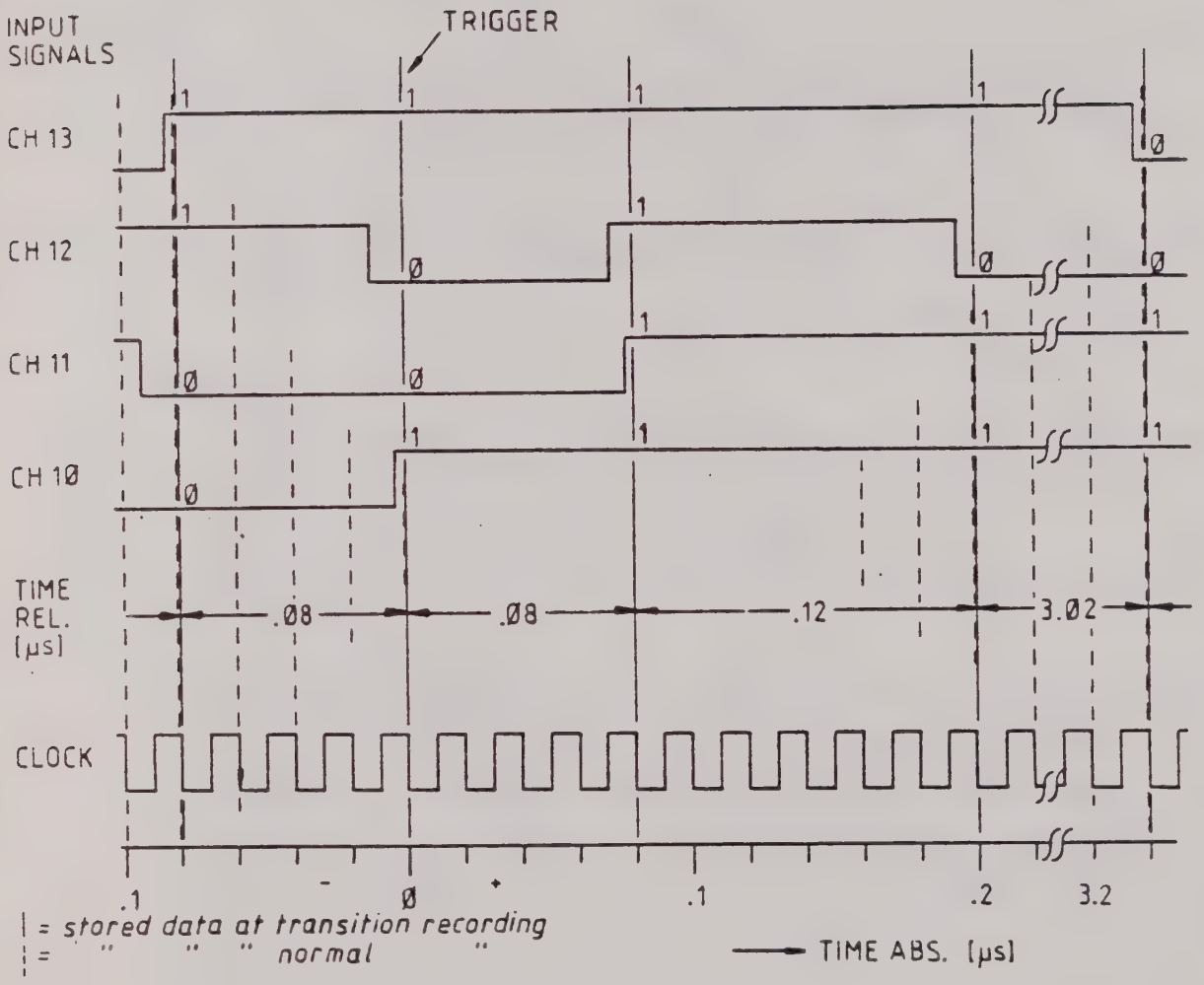


Figure 3-17 Transition Recording Timing Diagram

3. **TRANSITION RECORDING.** A data word is stored only when it differs from the previously recorded data word by at least one bit. During Transition recording all sampling is with the internal clock which is preset to 20 ns rate. Thus the smallest interval between two separately recorded data transitions equals 40 ns.
Transition recording is not possible when two master clocks have been assigned in the Configuration Menu. It is also not possible when in the Glitch mode or in Interlace.
Checking for the difference between data words can be limited to certain channel groups by selecting the probes whose data is to be sampled. See also **Figure 3-17, Transition Recording Timing Diagram**

4. **NO RECORDING.** No recording mode can be set for individual trigger levels, where the trigger words are searched but not recorded if found.

How To Set The Different Recording Processes

Refer to **Figure 3-14, Parameter Fields In The Trigger Sequence Menu** for all the parameter field numbers referred to here. Parameter field 12 at the top of the screen controls all the other levels, therefore if more than one type of recording is desired, field 12 has to be set at Level Select Recording. Then the fields below can be specified individually for other types of recording. If NO RECORDING is desired for any trigger level, this setting has to be entered first in one of the parameter fields identified as 13. The reason for this is that the roll key (9) will change the settings in all three parameter fields at once, except for the NO RECORDING setting. The remaining levels are set by rolling through with key (9) to the desired recording setting for both of them.

If the parameter field 12 is specified as Transition Recording, Data Qualified Recording, or Normal Recording, then all the parameter fields and trigger levels will be automatically set the same. If, however, Data Qualified Recording is selected in field 12, then recording can proceed somewhat independently on each trigger level because of preset qualifier words.

The recording conditions set in one level for Level Select recording are valid until the trigger executes and the trigger delay is over.

For further information on Transition recording and Data Qualified recording, see Section 4.1.3, 4.1.4 and 4.2.3, 4.2.4.

j. Data Qualifier Words

Words input in the Trigger Words Menu are used as qualifier words in Data Qualified recording. These words can be called up later in the Trigger Sequence Menu by inputting the word number from the Trigger Word Menu or its mnemonic.

In Level Select recording qualifier words can be selected for each trigger level. If more than one qualifier word is selected in a given trigger level, the KLA OR connects these automatically, and only one word needs to meet the qualifying condition for triggering to occur.

k. Time Measurement/Clock Counting (Option)

When this option is added to the KLA, the point in time when a word is detected during Transition recording and Data Qualified recording is stored. This time information can be stored in absolute time units with 10 ns resolution, or in cycles of the master clock M1. The setting for the time units to be used is made in field 14 as identified in Figure 3-17 for Data Qualified recording, and in Figure 3-18, for Data Qualified recording.

Data times are displayed in the data list next to the corresponding data. From the stored data times information, a timing diagram can be reconstructed which corresponds to recording made with a clock frequency of 100 MHz. Since only the data changes are recorded, the timing diagram extends over a longer time frame than a conventional timing diagram. (See also **Section 4.1.3, Transition Recording**).

l. Probe Selection For Transition Check

Field 15 shown in **Figure 3-15, Parameterfields in Trigger Sequence Menu** is used for setting the numbers of Probes to be checked for data transitions. This input is valid for all trigger levels jointly. Then, all data transitions happening on selected probe inputs are recorded on all channels.

SUMMARY OF INPUTS IN THE TRIGGER SEQUENCE MENU

1. TRIGGER CONDITIONS/TRIGGER LEVELS

Trigger level with a time frame limited at both ends:

WORD SEARCHED
1

SEARCH TIME WINDOW
2

INSTRUCTION IF FOUND
3

INSTRUCTION IF NOT FOUND
4

Example:
<4> IF WRD 7 OCCURS BETWEEN 00512 AND 00522 COUNTS, THEN GO TO <5> (next level)
ELSE RESTART

Trigger level with a time frame <u>not</u> limited at both ends:

FIRST WORD SEARCHED

EVENT COUNTER

SEARCH TIME WINDOW
no time limit at either end

INSTRUCTION WHEN FOUND

SECOND WORD SEARCHED optional

INSTRUCTION WHEN SECOND
WORD FOUND

Example:
IF WORD 8 OCCURS 00029 TIMES after 00007 COUNTS, THEN TRIGGER
BUT IF WORD INTAC OCCURS, THEN RESTART

2..CALLUP OF A WORD BEING SEARCHED

Input WORD NUMBER from Trigger Word Menu or
Input MNEMONIC
Use ROLL key (9) to scroll through the trigger word list when in SCREEN mode
Use UP or DOWN keys from key group (6) when in FIELD mode to display input or to jum] to TRIGGER LEVELS

3. EVENT COUNTER

Use with open time window
Direct numeric keyboard input 00001 to 65535 clock cycle counts

4. INSTRUCTION FIELDS

GO TO
RESTART
TRIGGER
ROLL THROUGH WITH KEY(9)

5. TRIGGER LEVELS

Minimum 5 and maximum 14 levels depending on other instructions and search windows seleicted.

6. TRIGGER FILTER

TRIGGER FILTER... (VALUE) ON ... (LEVELS)

Trigger Filter	05	ALL LEVELS
Trigger Filter	12	ON LEVELS 1. 2.XX 4.XX

Where the filter value is 0 to 15 clock cycles entered via numeric keyboard and levels are selected with ROLL key (9)

7. RECORDING

RECORDING PROCESSES:
- NORMAL
- DATA QUALIFIED
- TRANSITION
- LEVEL SELECT
- NO RECORDING

TYPE OF RECORDING:

DATA QUALIFIED RECORDING CRITERIA:
ON ONE QUALIFIER WORD OR ON TWO QUALIFIER WORDS WHICH ARE OR'ed.

TRANSITION RECORDING CRITERIA:
CHECK PODS... Specify pod numbers or "X" for pod not to be checked.

TIME MEASUREMENT/CLOCK COUNT

This option is available only with DATA QUALIFIED RECORDING or TRANSITION RECORDING and will count clock M1, or measure absolute time.

3.3.2.4 TRIGGER MONITOR

The trigger monitor is a display which appears in place of the Trigger Sequence Menu, and allows the user to keep track of the trigger word search status of the recording in progress. See **Figure 3-18, Trigger Monitor.** It automatically appears during recording in the Trigger Sequence Menu, or it can be called up by pressing the ROLL key (1) after a recording is finished. Pressing either one of the HOME keys will bring up the Trigger Monitor display, however, then it cannot called up again until after another recording is finished.

```
     TRIGGER FILTER 05 ON LEVELS XX.XX.  3.XX
     NORMAL RECORDING

     01 PASSES          00005 OCCURENCES FOUND
<1>  IF LD7 OCCURS      00007 TIMES ANYTIME WITH CLOCK M2, THEN GOTO <2>
     BUT IF WRD  3 OCCURS, THEN RESTART

     01 PASSES
<2>  IF IN23 OCCURS BEFORE 01000 COUNTS CLOCK M2, THEN GOTO <3>
                                              ELSE RESTART

     00 PASSES
<3>  IF OUT54 OCCURS 00001 TIMES ANYTIME WITH CLOCK INT, THEN GOTO <4>
     NO SECOND TRIGGERWORD

     00 PASSES
<4>  IF GLTCH OCCURS 0001 TIMES ANYTIME WITH CLOCK INT, THEN TRIGGER
     NO SECOND TRIGGERWORD
```

Figure 3-18 Trigger Monitor

Notes to Figure 3-18:
During high speed recordings there can be a difference between the number of searched events indicated by callout (3) and the number actually found at that time.
If a trigger level is passed through too quickly, it is possible to lose the information in that level , and the pass counter indicated by callout (1) will show too small a value.

Since the length of time it takes to show the latest information is essentially determined by the screen updates, if during recording a display other than the Trigger Monitor, such as a menu or time/data display is on the screen, the speed with which the KLA processor can follow the pass counter is considerably increased. When the Trigger Monitor is called up later, the pass counter values will agree with the actual count, even if trigger levels were passed through very quickly.

The Trigger Monitor display gives information on:

a. The path taken by the KLA to get to the trigger instruction, which is especially useful when the sequence selected allows for several possibilities.

b. The last trigger condition searched in the trigger sequence, which is especially useful if one of the searched words is not found and triggering is stuck.

c. The number of times a trigger level has been run through or jumped to

d. Indication of which trigger level is presently active

e. If the event counter is set, the number of events found so far is displayed.

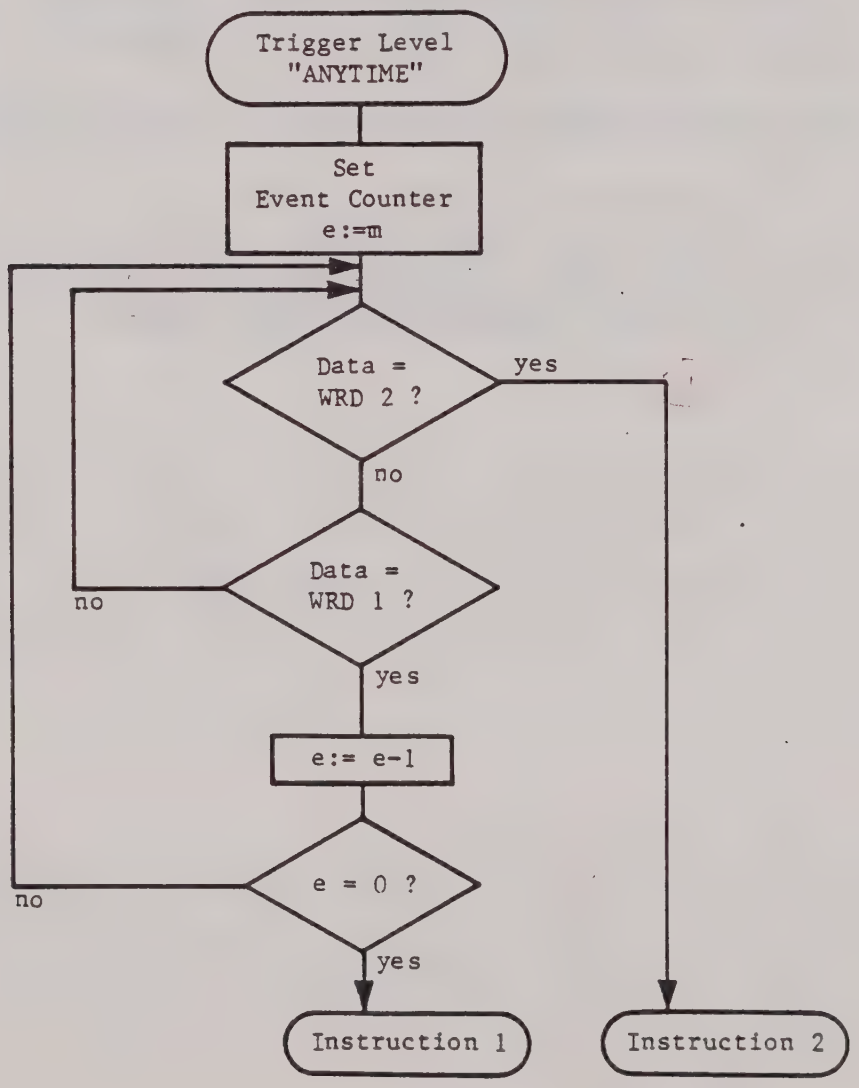
If for reasons of space, the Trigger Monitor does not display all trigger levels at the same time, these can be brought up with UP and DOWN directional cursor keys from key group (6), when in SCREEN mode; that is, the SCREEN key is first pressed before scrolling through the trigger levels.

3.3.2.5 TRIGGER LEVEL FLOW DIAGRAMS

Flow Chart For Trigger Levels

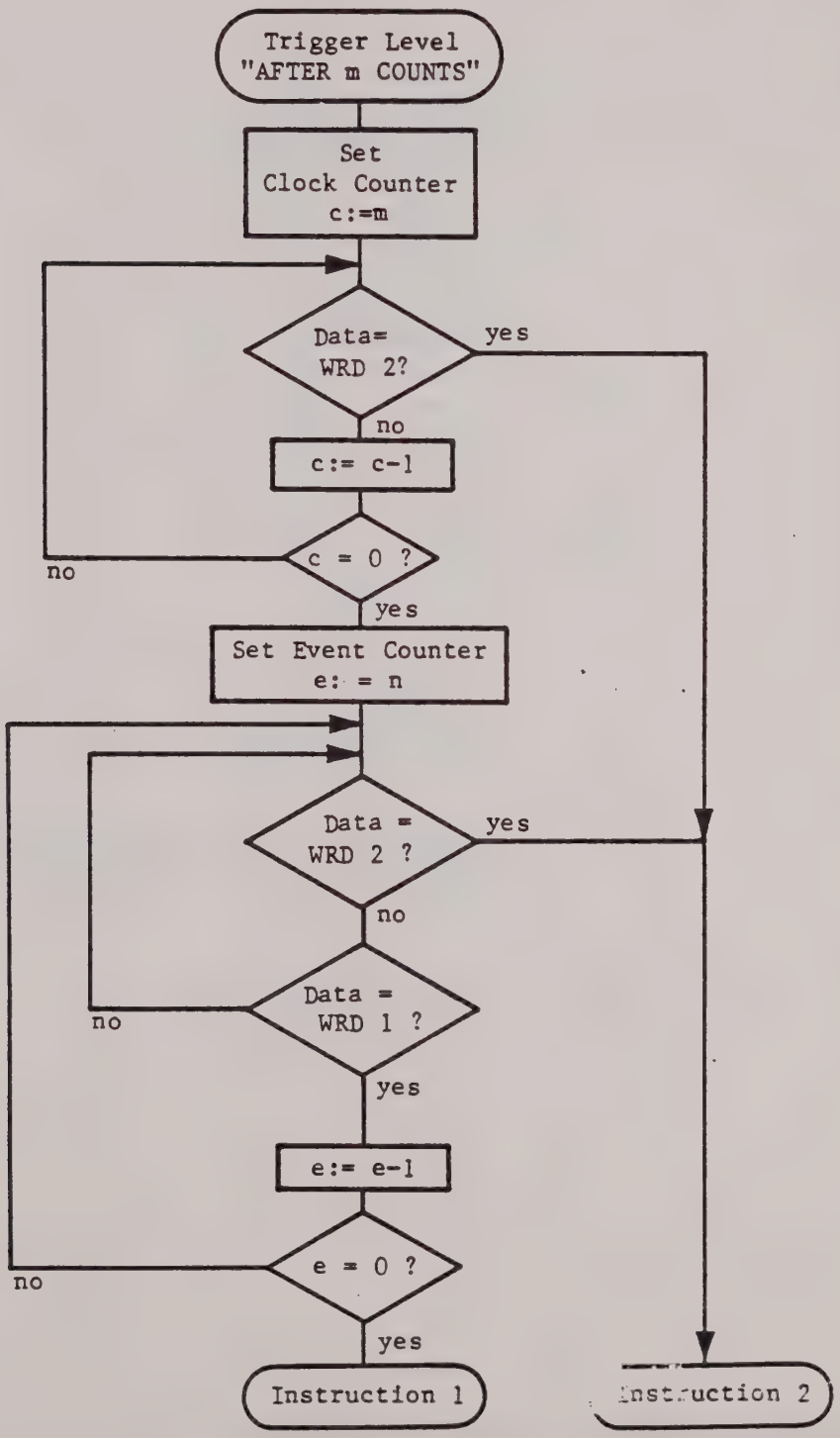
1. **Time Window "ANYTIME"**

<..> IF WRD 1 OCCURS m TIMES ANYTIME, THEN (INSTRUCTION 1)
BUT IF WRD 2 OCCURS, (INSTRUCTION 2)



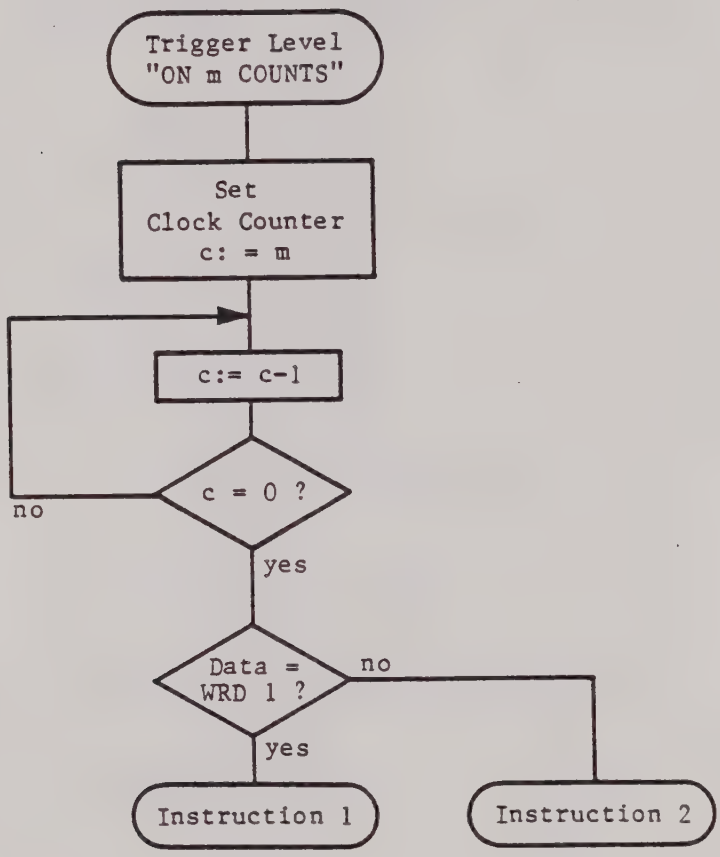
2. Time Window "AFTER m COUNTS"

<..> IF WRD 1 OCCURS n TIMES AFTER m COUNTS, THEN (INSTRUCTION 1)
BUT IF WRD 2 OCCURS, THEN (INSTRUCTION 2)



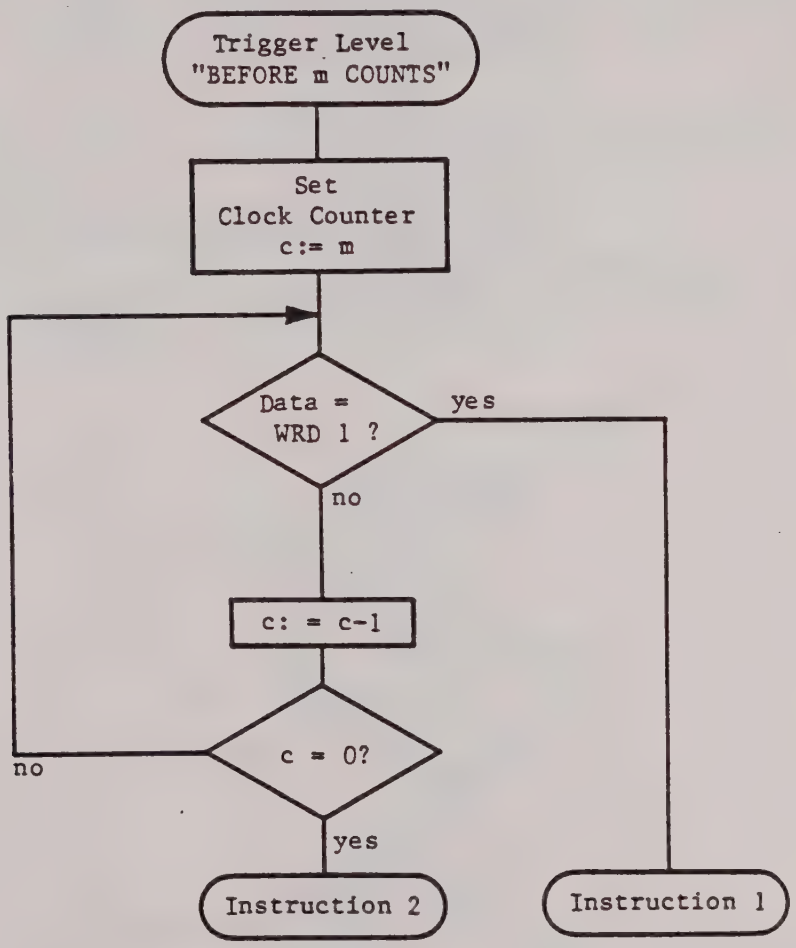
3. **Time Window "ON m COUNTS"**

<..> IF WRD 1 OCCURS ON m COUNTS, THEN (INSTRUCTION 1)
ELSE (INSTRUCTION 2)



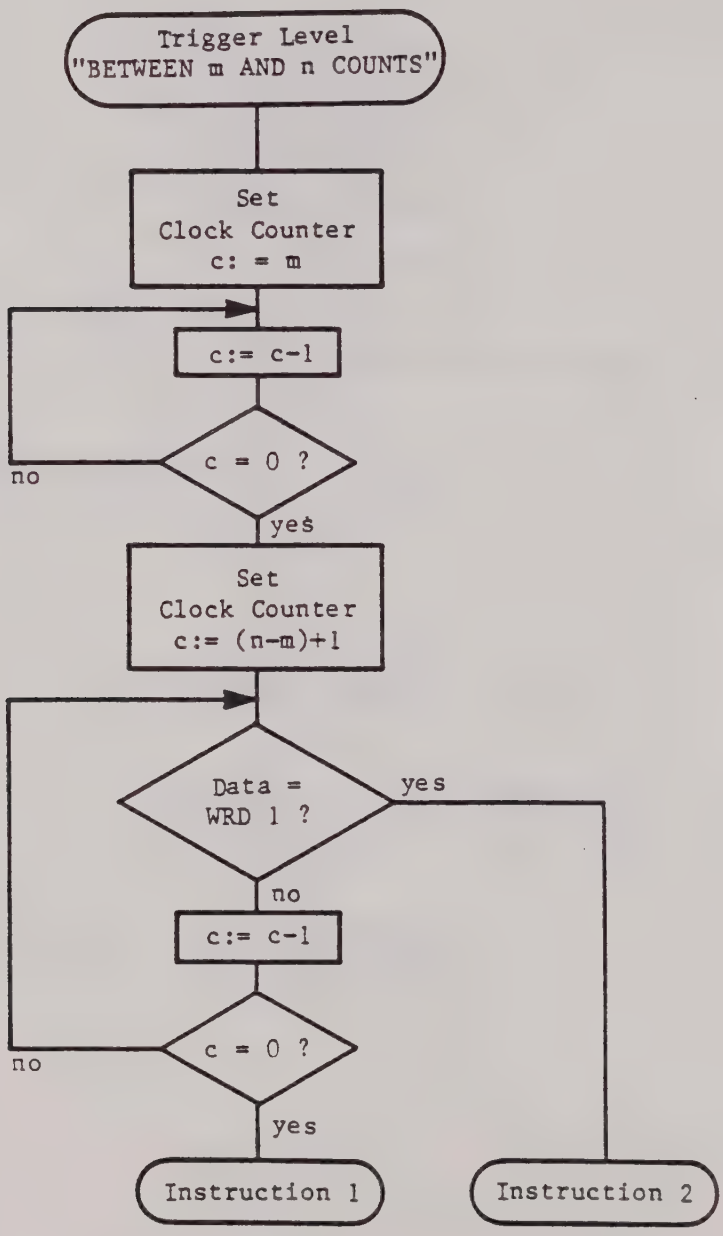
4. Time Window "BEFORE m COUNTS"

<..> IF WRD 1 OCCURS BEFORE m COUNTS, THEN (INSTRUCTION 1)
ELSE (INSTRUCTION 2)



5. Time Window "BETWEEN m AND n COUNTS"

<..> IF WRD 1 OCCURS BETWEEN m AND n COUNTS, THEN (INSTRUCTION 1)
ELSE (INSTRUCTION 2)



3.3.2.6 CURRENT CONCEPTS IN SEQUENTIAL TRIGGERING

KLA offers all of the sequential triggering capabilities available on the latest logic analyzers. In sequential triggerring instructions like:

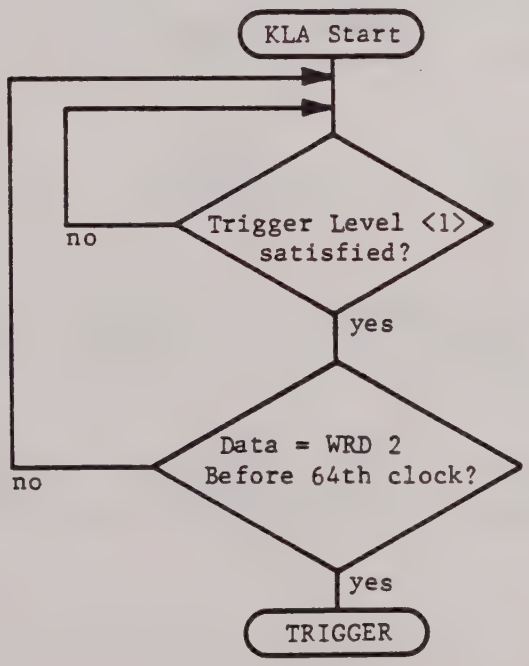
a. "THEN", "FIND IN SEQUENCE...", "TRIGGER ON ... FOLLOWED BY..."

are used to set the order in which the trigger events will occur. All of these connections are made by the KLA command GOTO, plus the ability to follow any path through the trigger levels, including jumps and loops. Any preset sequence is easily altered by giving jump addresses.

Connections like THEN usually leave the time distance between appearance of sequentially searched words open, thus they correspond to the KLA time window "ANYTIME". For example:

```
<1>  IF WRD 1 OCCURS 00025 TIMES ANYTIME, THEN GOTO <2>
<2>  IF WRD 2 OCCURS BEFORE 00064 COUNTS, THEN TRIGGER
                                          ELSE RESTART
```

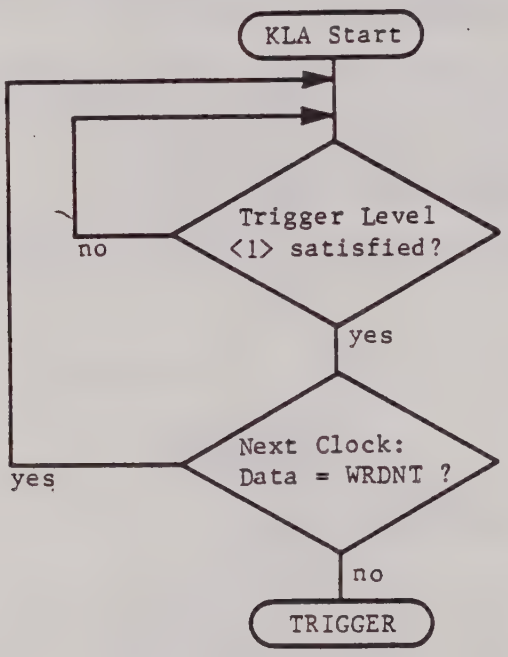
However, in step <2>, THEN instruction is given with a closed time window (ON..., BEFORE..., BETWEEN...)



"THEN NOT", "NOT"...

With this type of setting, the trigger condition is fulfilled when the trigger word is NOT found. When the word is found, the trigger level is not fulfilled, and the KLA executes a jump to the first trigger level and restarts the trigger word search again.

```
<1>  ...                                ..., THEN GOTO <2>
<2>  IF WRDNT OCCURS ON 00001 COUNTS, THEN RESTART
                                       ELSE TRIGGER
```



KLA can trigger on the non-occurrance of a certain word, with the time window entries "ON m COUNTS", "BEFORE m COUNTS" or "BETWEEN m AND n COUNTS. Jumping back to the first trigger level is not necessary for finding the preset trigger word.

Use of a limited time search window such as ON..., BEFORE..., BETWEEN... is typical for triggering on the non-appearance of a word. The instruction beginnning with ELSE applies to the fulfillment of the condition.

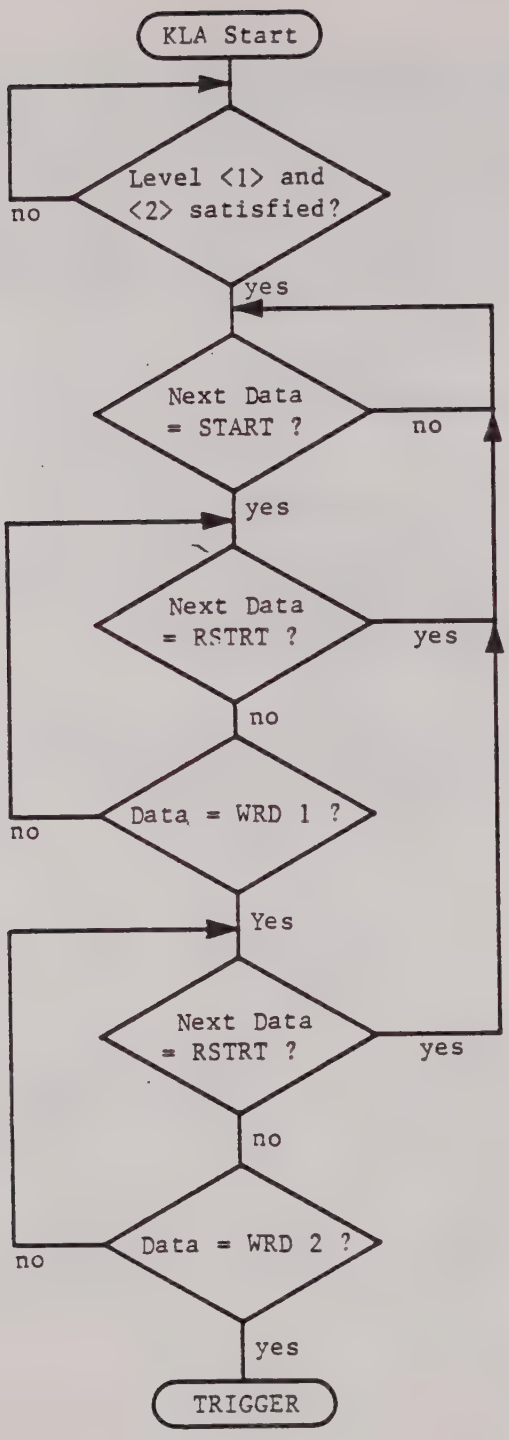
b. "RESTART", "RESET ON...", "WINDOW TRIGGER"

With a "WINDOW TRIGGER" setting, the data words are found within a certain area of the data stream; between the beginning and the end of a window. However, if the word corresponding to the end of the window appears before the trigger search is complete, then the trigger word search has to restart. Therefore a RESTART word or "RESET ON..." is defined. This second word is also searched concurrently during the entire trigger word search. If the RESTART word is found, it causes a jump back to the beginning of the window trigger.

A window trigger for the KLA might look like the following example

```
<1>  ...                                    , THEN GOTO <2>
<2>  ...                                    , THEN GOTO <3>
<3>  IF BEGIN OCCURS 00001 TIMES ANYTIME, THEN GOTO <4>
     NO SECOND TRIGGERWORD
<4>  IF WRD 1 OCCURS 00023 TIMES AFTER 00014 COUNTS, THEN GOTO <5>
     BUT IF RESTART OCCURS, THEN GOTO <3>
<5>  IF WRD 2 OCCURS 00001 TIMES ANYTIME, THEN TRIGGER
     BUT IF RESTART OCCURS, THEN GOTO <3>
```

Triggering is on the last word searched in this example. Searching for the word RESTART occurs parallel with trigger levels 2 and 3 as a jump condition. The following flow diagram illustrates this example:


KLA Start
Level <1> and <2> satisfied?
no
yes
Next Data = START ?
no
yes
Next Data = RSTRT ?
yes
no
Data = WRD 1 ?
no
Yes
Next Data = RSTRT ?
yes
no
Data = WRD 2 ?
no
yes
TRIGGER

c. "ARM"

This is a precondition which prepares the logic analyzer for triggering. Usually it is a word which must be found, once or several times before the real trigger condition is searched.

For the KLA, the trigger level(s) run through to find the arming word(s) before jumping to the trigger level containing the trigger command, is the "ARM" precondition.

d. "DATA QUALIFIED CLOCKING", "SELECTIVE TRACE", "TRACE ONLY..."

With these conditions, data can only be recorded if it agrees with qualifier words consisting of 1,0,X.

In the Data Qualified Recording operation, the KLA separates qualification from triggering. The qualifying conditions do not necessarily cause triggering, and conversely, events which do not correspond to the qualifying conditions can be triggered on. This differs from clock qualification, where words which do not correspond to the qualifying conditions are not sampled, and cannot be used as trigger events. In addition, in the Configuration Menu, up to six OR connected clock qualifier words of 6 bits each can be set for each clock.

e. TRANSITIONAL CLOCKING

KLA Transitional Recording corresponds to this procedure. An additional feature of the KLA is the TM option which permits a time to be recorded with each transition event. Later a timing diagram of somewhat extended time window dimensions can be reconstructed from this data.

3.3.3 SPECIAL MENUS

These are the COMPARE MENU, STORE/RECALL MENU, and I/O MENU. The STD/SPEC key (2) is used to switch to the special menus from the standard menus. Selection of special menus is by the ROLL key (9).

3.3.3.1 COMPARE MENU

This is the menu for setting parameters for cyclic comparison of reference data with source data also referred to as babysitting. See **Figure 3-19, Compare Menu—One Segment Comparison.** This is a cyclic process of automatic data comparison and display which can be used to detect and analyze intermittent errors.

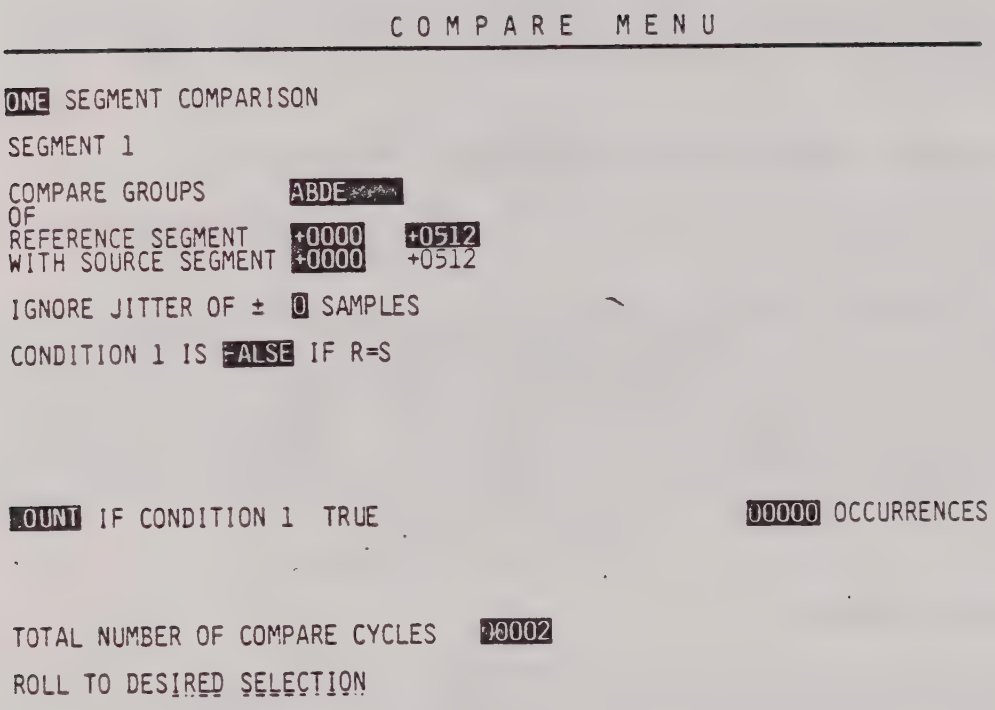

COMPARE MENU
ONE SEGMENT COMPARISON
SEGMENT 1
COMPARE GROUPS ABDE
OF
REFERENCE SEGMENT +0000 +0512
WITH SOURCE SEGMENT +0000 +0512
IGNORE JITTER OF ± 0 SAMPLES
CONDITION 1 IS FALSE IF R=S
COUNT IF CONDITION 1 TRUE 00000 OCCURRENCES
TOTAL NUMBER OF COMPARE CYCLES 00002
ROLL TO DESIRED SELECTION

Figure 3-19 Compare Menu--One Segment Comparison

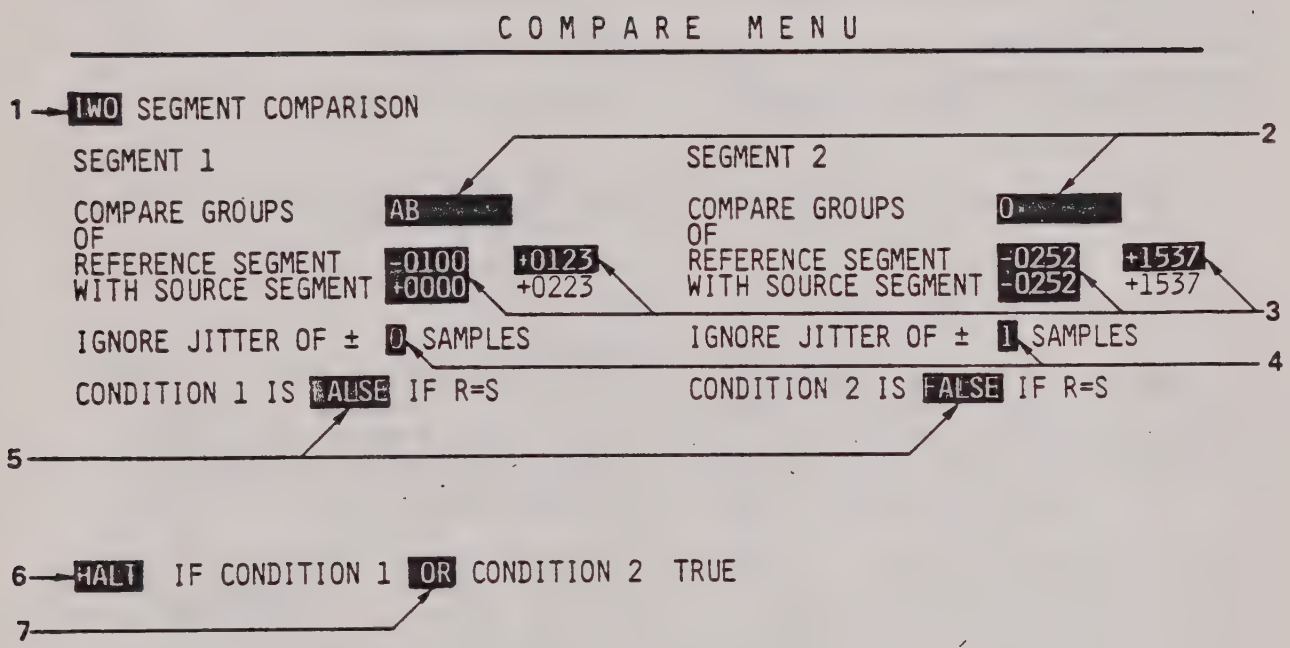


Figure 3-20 Parameter Fields In Compare Menu—Two Segment Comparison

The reference data necessary for this comparison can be a previous recording of a test run, or a control run with the same system being tested. The reference data can be stored on a diskette, or read in over one of the interfaces. See Section 3.3.3.3.

Before executing a cyclic comparison, Compare Menu inputs have to be selected. See **Figure 3-20, Parameter Fields In Compare Menu** for the field reference numbers listed below.

PARAMETER FIELD	CALLOUT NUMBER IN FIGURE 3-20
Number Of Segments To Be Compared (Selection is either ONE or TWO)	1
Channel Groups	2
Segment Boundaries	3
Comparison Tolerances	4
Search For Data Equality/Inequality	Fields 5, 6, and 7

To start a cyclic Record/Compare press the EXECUTE key (19)
To make a single run comparison press the RUN/STOP key (20)

Channel Groups For Comparison

If the comparison is not over the full number of KLA channels, then the user can select the channel groups for comparison in field 2. Channel selection is most useful when only a portion of the data repeats over some of the channels, and can be compared; for example, when the address bus runs in a reproducible loop, but the data coming to the bus can vary because it comes in on I/O ports.

In the Compare Menu the cursor is positioned by using LEFT, and RIGHT movement cursors from key group (11). Entering an "X" will turn off and remove those channel groups from the comparison. Inputting a letter will turn them on again.

Table 4 Inputs In The Compare Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	Segment Comparison	Comparison of 1 or 2 memory segments	ONE or TWO	ROLL
2	Groups	Channel Group Selection	Letter A...H of compared channels	A-H, X
3	OF... SEGMENT	Segment boundaries	Any starting and ending address from KLA address space[2]	+,-
4	JITTER	Comparison Tolerance	± 0...±9	0...9
5	---	Define conditions for data equality	TRUE/FALSE	ROLL
6	---	Halt/count/store if	STORE IF... HALT IF... COUNT IF...	ROLL
7	---	Condition for stop count	COND 1 AND COND 2 TRUE COND 1 OR COND 2 TRUE	ROLL

Segment Boundaries

Field 3 shown in **Figure 3-20, Parameter Fields In Compare Menu** is where the user enters the starting and ending addresses for the memory areas to be compared. Source and reference memory can be defined independently at different addresses, however, the length of the segments being compared must be identical.

The ability to define segment boundaries makes it possible to limit comparison areas which is necessary whenever data is reproducible only in short fragments. An example would be triggering on a subroutine in a microprocessor program, determining the address for the subroutine, and then executing the comparison in the exact memory segment where this subroutine is located.

Comparison Tolerance (Jitter)

Sometimes it is necessary to ignore jitter during comparison of source and reference data so that the two data streams can be considered identical. This comparison tolerance is entered in field 4 of the Compare Menu, from 0 to ± 9 memory places.

Example:

Assume that memory address x in the reference memory and y in the source memory are assigned to each other for data comparison. Then:

1. For A Comparison Tolerance Of 0 Samples: Data is considered identical only if a data transition (0 to 1 or 1 to 0) at address x in reference memory, appears exactly at address y in source memory.

2. For A Comparison Tolerance of ± n Samples: Data is considered identical only if the same transition is found anywhere between x-n and x+n in reference memory, and y-n and y+n in the source memory.

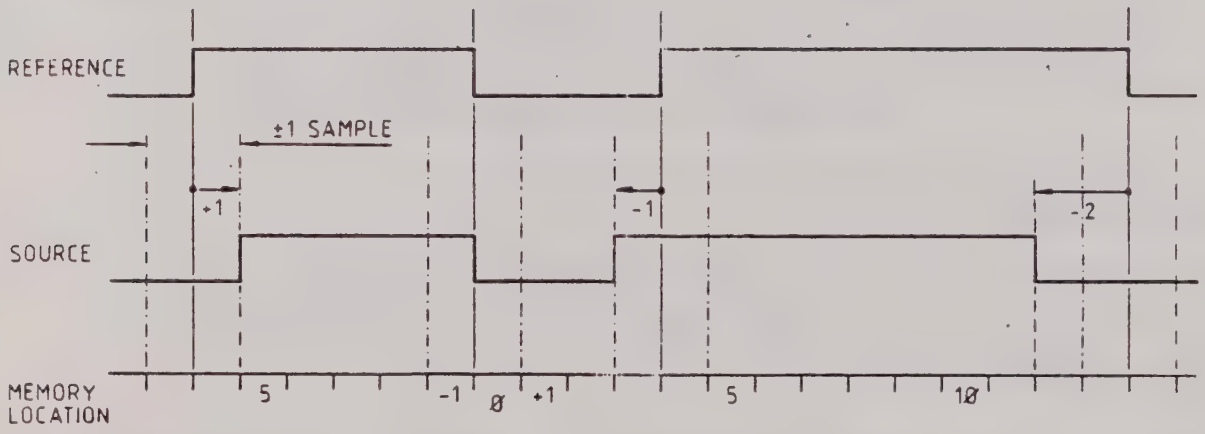


Figure 3-21 Data Comparison With Jitter Of ± 1 Sample One Reference And One Source Channel Have Been Removed

In **Figure 3-21, Data Comparison With A Comparison Tolerance of ± 1 Sample** shows four transitions. The first, second, and third transitions are considered identical. The second transition would be interpreted as having a comparison tolerance of 0. But the fourth transition is considered to be not identical.

Preset comparison tolerances are most useful with recordings done with the internal clock of the logic analyzer, which is asynchronous to the system clock. Data can be caught with an uncertainty of ± 1 sample, so that two recordings compared with each other will differ only by the preset comparison tolerance number of memory places in the position of their data transitions.

With synchronous systems, where data is recorded with the system clock, there are asynchronous signals whose timing is unclear. The timing of the appearance of asynchronous signals can be checked by presetting comparison tolerances.

Search For Data Equality/Inequality

In all cases where reference data and source data differ by more than the preset comparison tolerance parameters, they are treated as a non-identity. Source and reference data are considered unequal when the data transition at the assigned position x in the source memory is not found in source memory between addresses y-n and y+n.

True/False Definitions

Refer to field 5 in **Figure 3-20, Parameter Fields In The Compare Menu.** A data equality is searched for within the Compare Menu. The search for data equality is done by setting a search condition (CONDITION 1 and CONDITION 2) is set as either TRUE or FALSE, for when data is found. See Field 5 in **Figure 3-20.** Depending on whether the conditions are true or false, a Halt, Count, or Store function is executed.

Count/Halt/ Store IF...

Refer to **Figure 3-20,** field 6. There are three selections in this parameter field: HALT IF..., STORE IF..., COUNT IF... which can be selected by the ROLL key (9). In this field the user sets whether a recording is to be stored in the source memory, or "frozen" on diskette when the searched situation is found.

In HALT IF... mode, cyclic record/compare is interrupted if the searched condition is met: the data of the last recording is preserved in the source memory.

In STORE IF... mode, the source data is stored on diskette if the searched condition is fulfilled. The recording process begins with the reference file, a file number is entered on the Store/Recall Menu (discussed in the next section 3.3.3.2) in the reference file column under STORE.

In COUNT IF... mode, shown in **Figure 3-19**, the present counter status for frequency of appearance of the searched condition is shown. There is also a counter which indicates how many record/compare cycles have been executed up to then.

If reference and source memories are compared in only one segment then HALT/COUNT/STORE will occur if CONDITION 1 is TRUE. If a data inequality is sought, choose FALSE in field 5. To find a data equality, set it at TRUE.

If reference and source memories are compared in two segment comparison, HALT/COUNT/STORE will occur if only one or if both conditions are true. If data inequality is to be detected in both segments, set FALSE in field 5 and OR in field 7. If data equality is searched, set field 5 at TRUE, and field 7 at AND.

Cyclic data comparison with Transition Recording is not useful. Since individual data words are stored at only one memory position, cyclic comparison makes no sense.

3.3.3.2 STORE/RECALL MENU

The user can store system setups on the diskette that incorporate changes made to the system diskette to store the most frequently used setup, rather than the simplest possible setup which is delivered with the system. These setup files can be stored under user assigned names. Up to 10 complete system setups are stored. A setup consists of all parameters in the input fields in reverse video at the time of storage.

In addition to the setup files, up to 10 complete reference memory contents can be stored. If a recording in the source memory is to be stored on the diskette, this data must first be transferred to reference memory as follows:

1. Go to a timing or data display and callup SRC ⟶ REF in the memory field.
2. Press EXECUTE key (19)

All the information including time and data display is stored on diskette, and available for subsequent analysis.

When the KLA is turned on, files 0 (default files) are loaded. Therefore, it is recommended that either the most frequently used setup be stored in these files, or else the setup that provides the most advantageous starting point for the necessary changes.

File 0 on the diskette delivered with the unit corresponds to the simplest possible setup, which is designed to step the user from the easiest to the more complex capabilities of the instrument in successive small steps. It is a good idea to keep the default file intact, whenever several people use the KLA, or long intervals occur between utilizations by a single user.

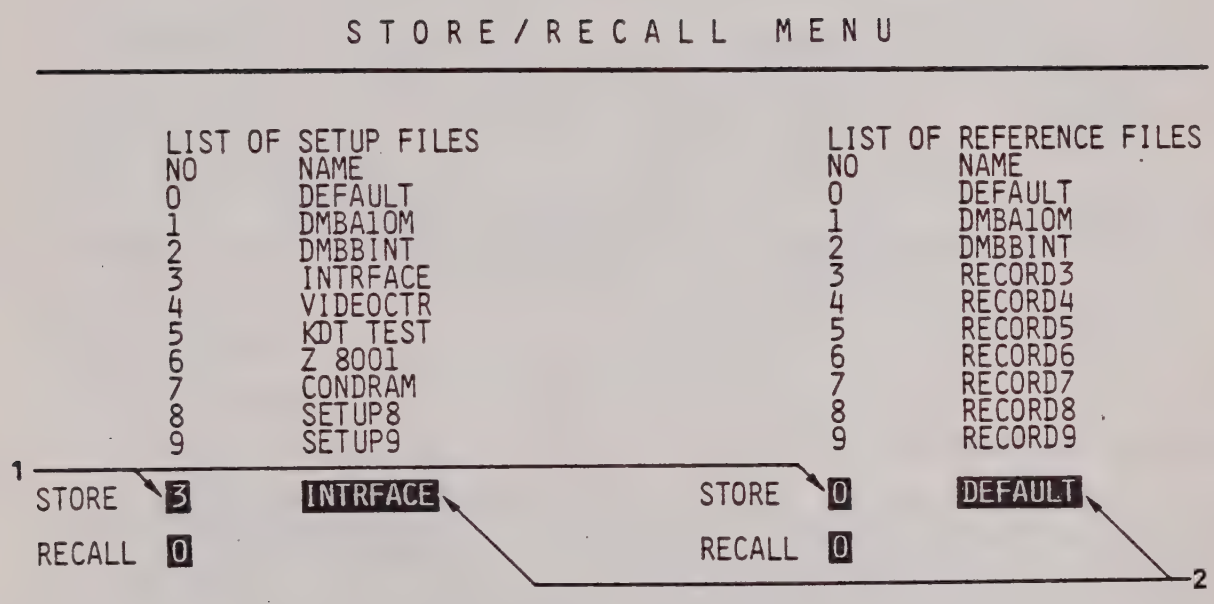


Figure 3-22 Parameter Fields In Store/Recall Menu

See **Figure 3-22, Parameter Fields In Store/Recall Menu** for the two fields where parameters are entered. Field 1 is the file number, and field 2 the file name parameter field. Execution of the Store/Recall process is with the EXECUTE key (19). As seen in **Figure 3-22** the file names and file numbers are listed in two columns as Setup Files and Reference Files. File numbers (0 to 9) are input in fields identified as 1, and file names of up to 8 characters are entered in fields identified as 2. After execution of the storage process, the file name appears next to the file number on the list above the parameter fields. Table 6 summarizes the inputs in the Store/Recall Menu.

Table 5 Inputs In The Store/Recall Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	STORE... RECALL...	Store in memory callup of setup or reference files	0...9	0...9
2	STORE...	Name under which file is to be stored	up to 8 characters	A...Z, SHIFT X

Treatment Of Read and Write Errors

When the device is turned on, the list of file names is read out, along with the operating program, and both default files. Any read errors originating during reading of this dirctory are corrected during repeated read attempts. The directory, whether correct or not, is accepted after the tenth read attempt at the latest. For example, erroneous names or symbols will be present in the Store/Recall menu in the case of an erroneous directory. Callup of the desired file is still possible.

Read errors originating during recall of a file in the Store/Recall Menu are corrected by repeated read attempts. After the tenth read attempt however, the screen will display "PERMANENT DISK ERROR". The user should then test whether files on other error-free diskettes also show correctable read errors, or if individual files or diskettes are destroyed or defective.

If write errors happen repeatedly during storage of a Setup or Reference file, after the tenth write attempt the message "PERMANENT DISK ERROR" appears on the screen. In this case, try storing another diskette. Use a new Kontron diskette with system software. If this is also unsuccessful, a hardware problem may be involved. Call your Kontron Service Representative.

3.3.3.3 I/O MENU

The I/O Menu (See **Figure 3-23, Parameter Fields In The I/O Menu**), is used to set the outputs of the KLA.

Interface parameters can be set using the inputs provided on the I/O menu. These are listed below in **Table 6, Parameter Fields In The I/O Menu**

Table 6 Parameter Fields In The I/O Menu

PARAMETER	FIELD NUMBER IN FIGURE 3-23
Control	1
CTRL Printer Interface	2
Callup Interface Test	12
Display Received Data	13
For serial interface with remote option Serial A or serial printer port	
Baud Rate	3
Number of Data Bits	4
Parity Bit	5
Number of Stop Bits	6
For remote mode option with Serial A only	
Computer/Terminal Function	7
Full/Half Duplex Operation	8
CTRL Handshake	9
If the software handshake is selected	
Synchronization Character	10
Delay	11
For IEEE-488 interface (GPIB if selected)	
GPIB Address	14
End Character	15
SRQ Function	16

Parameter fields belonging to an optional interface not included in the device cannot be called up on the screen in the I/O Menu.

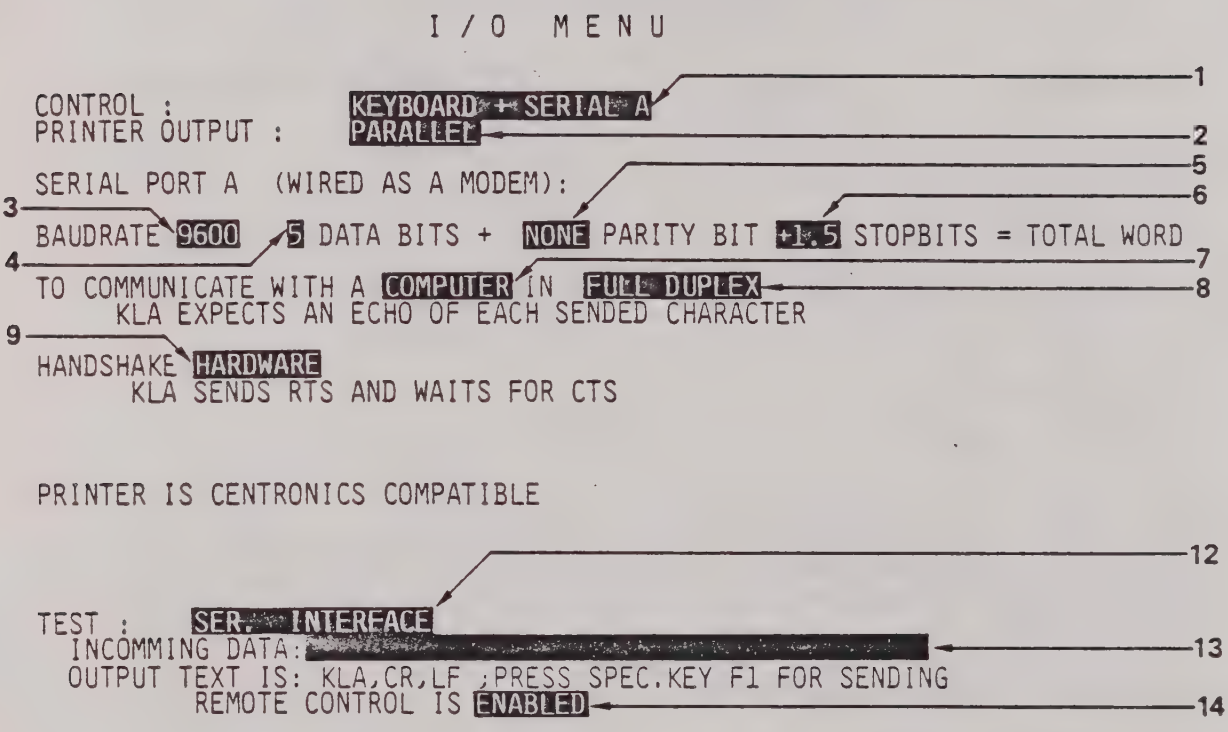


Figure 3-23 Parameter Fields In The I/O Menu

Some of the parameter settings listed in Table 6 will now be explained.

a. Control Setting

In field 1 the user selects the control point for individual device functions. The available selections are:

Keyboard
Keyboard and Serial A
Serial A
Keyboard and GPIB
GPIB

If control selected in this field is one of the two remote interfaces, (Serial A or GPIB), keyboard control is retained as long as the remote operation in field 18 is not enabled. If remote operation is enabled, switching back to the keyboard is only possible with the proper command from the interface.

b. Printer Interface Setting

In field 2, the user selects one of the two printer ports available for output. Data output on the activated printer port begins by pressing key F1 at which time the present contents of the screen are printed out. A serial printer will print out menus and data lists, however, a parallel printer is needed for printing the graphics of the timing diagram. In the data list, the memory area to be printed out can be defined by setting boundaries S and C.

c. Interface Parameters

In fields 3, 4, 5, and 6 as shown in **Figure 3-23**, baud rate, number of data bits, parity, and stop bits are set. These are normally set for the serial printer port Serial B. If the optional remote interface Serial A is available, then they are set for the Serial A interface option.

d. Switching Functions Computer/Terminal

In field 8, full or half duplex mode of operation is selected. Then in field 7, the user selects which of the two devices sends and which one receives an echo. If the other device is functioning as a computer, the KLA expects to receive a full echo for each symbol sent. If the other device is functioning as a receiving terminal, the KLA will send an echo for each symbol sent.

In half duplex operation, the data path is one-way, therefore sending of an echo is not possible. The setting in field 7 has no application in the half duplex operation.

e. Handshake

The type of handshake is set in field 9. The selections are hardware handshake, software handshake, or no handshake.

With the hardware handshake setting, the KLA sets the request-to-send (RTS) lead, and waits until the clear-to-send (CTS) lead is set by the other device before sending out the data.

The software selection is the synchronization to a certain symbol. The sync symbol is entered in field 11 in the form of two hexadecimal symbols which represent the corresponding ASCII symbols. After receiving the sync symbol, KLA waits for another user selectable time interval before sending out the next data block. This user selectable time interval is set in field 11, and is necessary for meaking sure that the other device is free to receive, before the KLA sends out more data.

f. Interface Test

Before starting to use remote control over one of the interface functions, especially when remote control over serial A does not seem to be functioning properly, it is recommended that the user perform an interface test in field 2 of **Figure 3-23, Parameter Fields In The I/O Menu.**

When a test of the SERIAL INTERFACE is executed, the data received on serial A port is directly displayed in field 13, which is comparable to a receiving terminal.

A test string can be sent over serial A (remote control), serial B, or parallel printer port by pushing key F1. The receiving instrument should get the following data:

```
KONTRON LOGIC ANALYSER
ASCII TEST: !"§$%&'()*+,-/0123456789
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG !
```

after the interface test is complete, or the menu has been changed, key F1 is restored to its regular function which is to start output from the KLA.

The KLA has four interfaces available. These are:

1. RS-232C printer port

2. Parallel printer port, Centronics compatible

3. Remote RS-232C interface. This is an option which gives remote control and data transfer capabilities to the KLA

4. IEEE-488 (GPIB, IEC bus) two-way interface. This is an option which also gives remote control and data transfer capabilities to the KLA.

Interfaces 1 and 2 listed above allow the print-out of any display: menu, timing diagram or data list via keyboard commands given from the KLA. The optional interfaces listed in 3 and 4 above allow full two-way remote control operation of the KLA, including programming of menus, and Store/Recall operations from diskettes using a macrolanguage. Complete instructions on how to use the option are shipped with the option.

Parallel/Serial Conversion Switch For Printer Port

On the interface board, which is the second board from the top in the KLA, are three slide switches. These switches enable the serial printer port versus the parallel printer port depending on left or right positioning. To reach these switches, remove the rear panel, by removing the four Phillips screws and access the KLA cardcage. The three slide switches are directly behind the printer and serial interface plugs. See **Figure 3-24, Parallel/Serial Conversion Switch For Printer Port.**

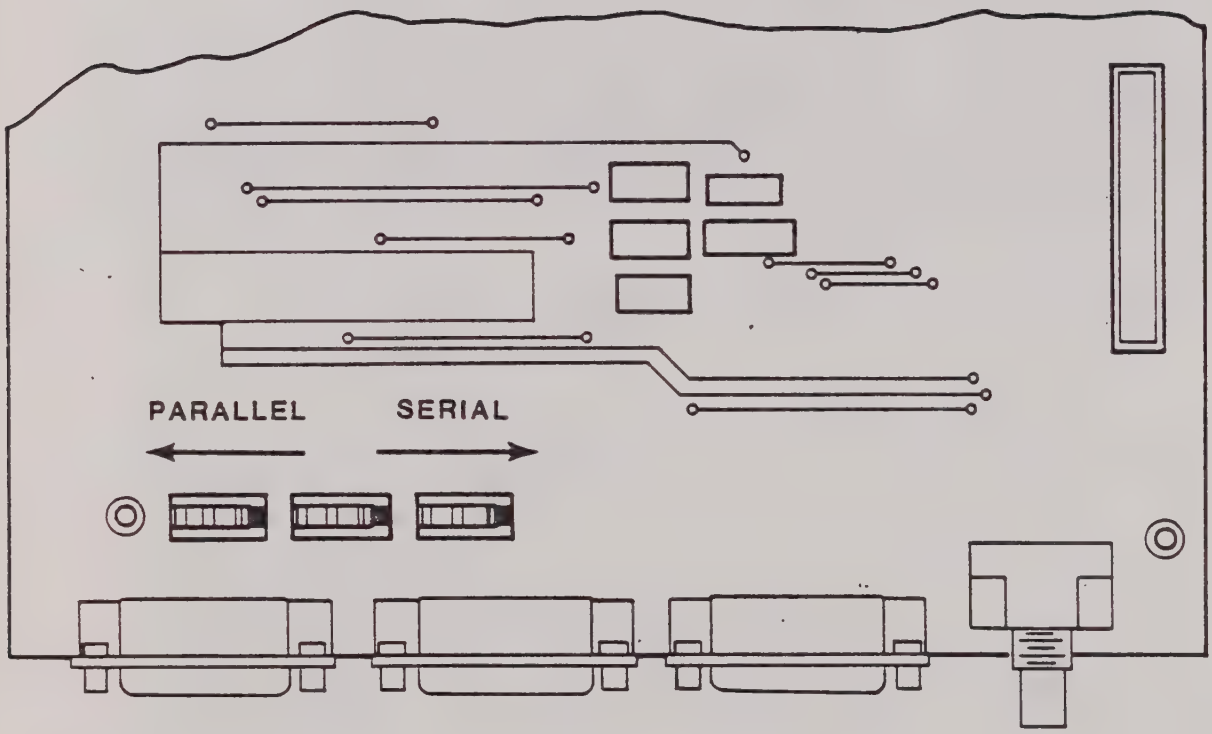


Figure 3-24 Parallel/Serial Conversion Switch For Printer Port

Looking at the switches from the rear of the KLA, the switches are set as follows:

All three switches pushed LEFT = Printer Parallel Port
All three switches pushed RIGHT = Printer Serial Port

The KLA interfaces output from the following plugs:

INTERFACE	PLUG
Menu SERIAL A INTERFACE	SERIAL INTERFACE
Menu SERIAL B INTERFACE	PRINTER PORT
Menu PARALLEL INTERFACE	PRINTER PORT

For pin assignments of the printer ports see **Chapter 7 Schematics/Pin Assignments.**

Table 7 summarizes the inputs from the I/O Menu.

Table 7 Inputs In The I/O Menu

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	CONTROL	Control of device	Keyboard Keyboard +Serial A[1] Serial A Keyboard + GPIB GPIB	ROLL
2	PRINTER OUTPUT	Set Printer interface	Serial B Parallel	ROLL
3	BAUD RATE[1]		110, 150, 300, 600, 1200, 2400, 4800, 9600	ROLL
4	DATA BITS [1]		5, 6, 7, 8	ROLL
5	PARITY BIT [1]		EVEN,ODD NONE	ROLL
6	STOP BITS [1]		1, 1.5, 2	ROLL
7	ECHO [1]	set echo send/receive device	COMPUTER TERMINAL	ROLL
8	DUPLEX SETTING[1]	set full or half	FULL DUPLEX HALF DUPLEX	ROLL
9	HANDSHAKE[1]		NONE HARDWARE SOFTWARE	ROLL
10	CHARACTER [1]	sync of symbols	TWO HEX SYMBOLS	0...9, A...F
11	DELAY [1]	sending delay	1, 10, 100, 1000	ROLL
12	TEST [1]	interface test callup	NONE SERIAL INTERFACE	ROLL
13	INCOMING DATA[1]	display of data received via interface SERIAL A		
14	—	Activate remote operation [1]	ENABLED DISABLED	ROLL
15	--	End symbol sent by KLA[1]	--	ROLL

Table 7 Inputs In The I/O Menu (ctd)

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
16	SRQ Trigger		TRIPPER RELEASE	ROLL

NOTE TO TABLE 7

1 These settings or input fields appear only when the interface option is present and is called up.

3.4 DATA DISPLAY

3.4.1 TIMING DIAGRAM DISPLAY

Even though it has up to 64 channels, the KLA is capable of displaying all of its channels in a timing diagram. This timing diagram can be an 8-channel or a 16-channel display. The channels to be displayed can be selected at random, or scrolled through vertically with SCREEN MOVE.

To display a Timing Diagram:

1. Press key (4) TIMING
2. Press key (8) SCREEN
3. Scroll up or down with UP or DOWN keys (6)

For easy recognition, all channels can be assigned mnemonics. Time measurement with two cursors, and word search are also possible. Parameters can be entered in input fields around the actual timing diagram display. See **Figure 3-25, 8- and 16- Channel Timing Diagram Displays**, **Figure 3-26, Sub-menus In The Timing Display**, and **Figure 3-27, Input Fields In The Timing Display**. An explanation of the various areas of the timing display is given in the next section.

3.4.1.1 EXPLANATION OF THE AREAS OF THE TIMING DISPLAY

In addition to the graphics of the timing diagram, the following information appears on the KLA screen in timing display:

	SCREEN AREA	CALL OUT NUMBER IN FIGURE 3-25 AND FIGURE 3-26
a.	Raster	1
b.	Resolution	2
b.	Unresolved Areas	3
c.	Cursor Line (C)	4
d.	Trigger Line (T)	5
e.	"Start Magnification" (S)	6
f.	Address and Data At S, C, and T	7
g.	Time Distances Between S, C, and T	8
h.	Internal Clock Rate For Recording	9
i.	Orientation Scale	10
j.	Glitches	11

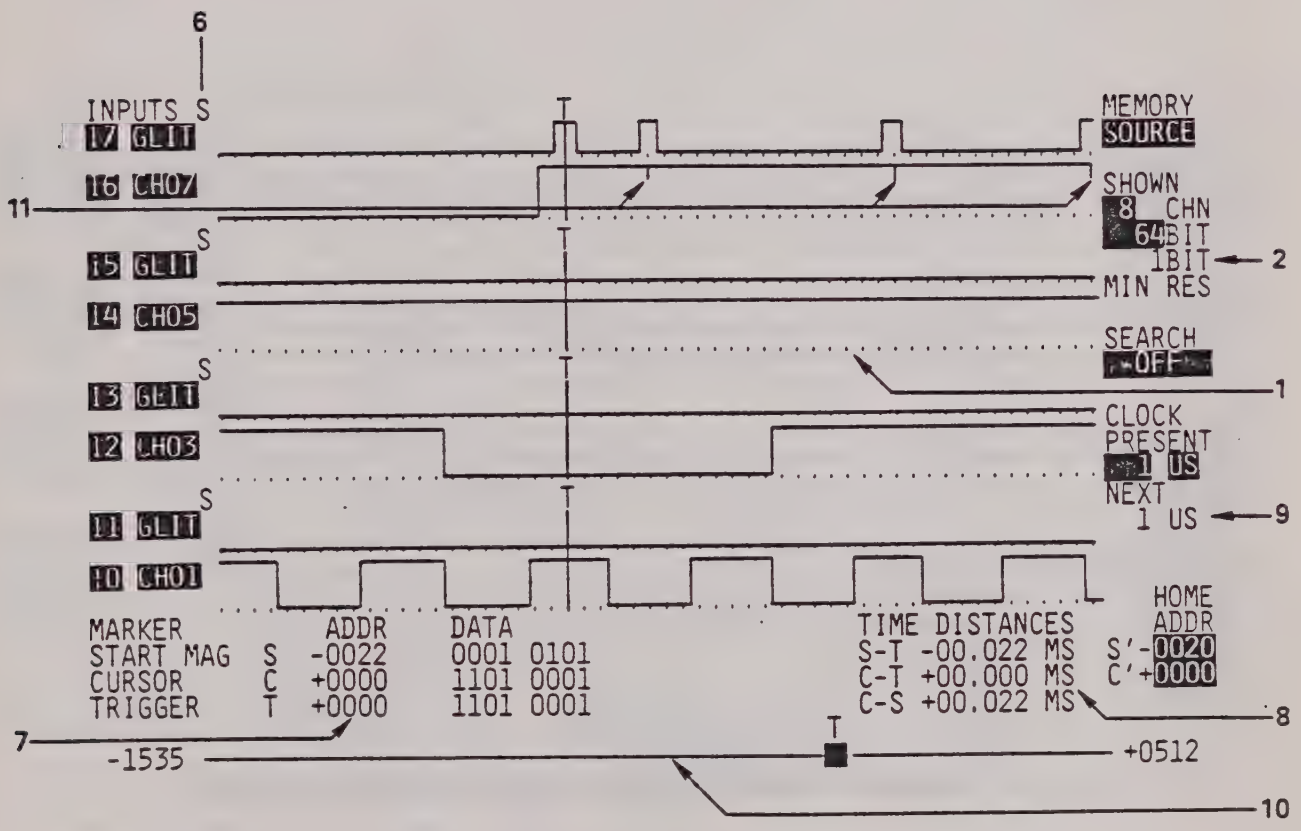


Figure 3-25 8-Channel Timing Display

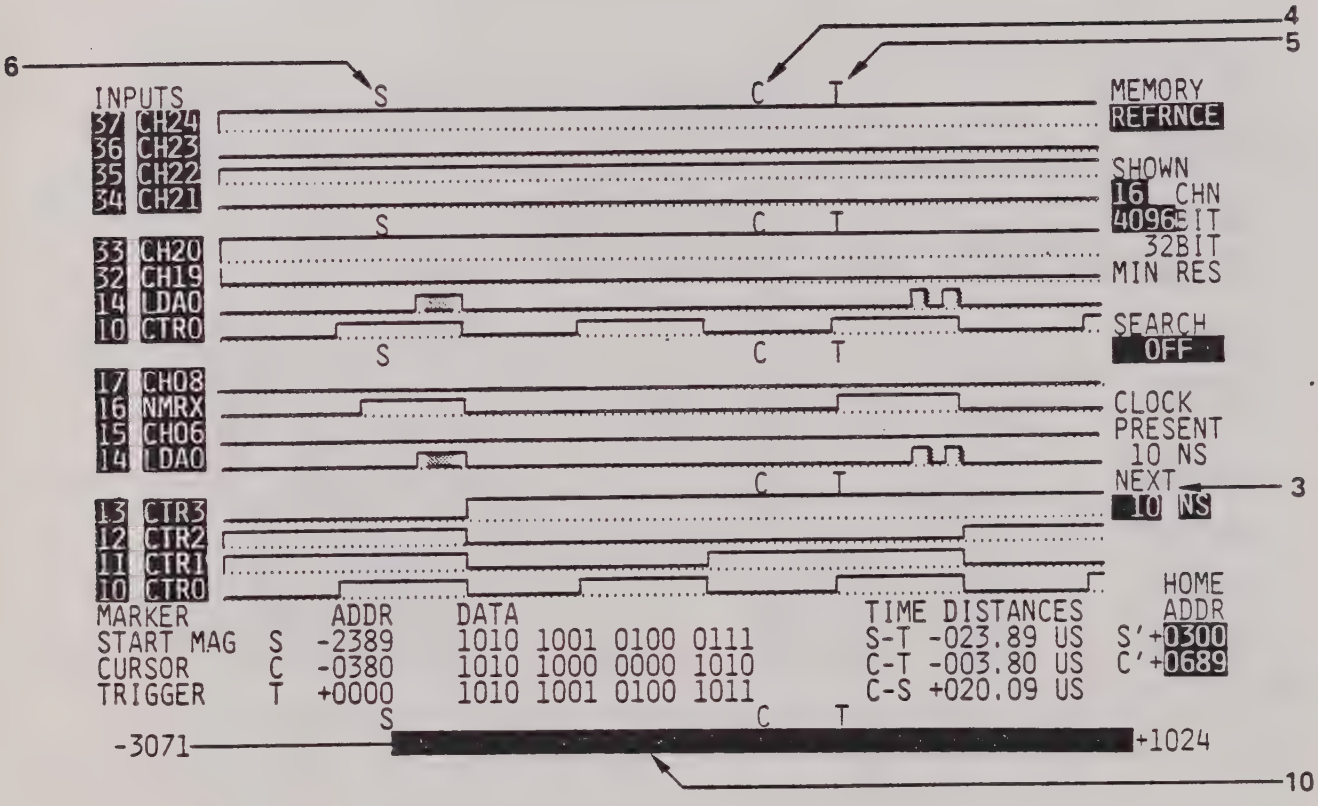


Figure 3-26 16-Channel Timing Display

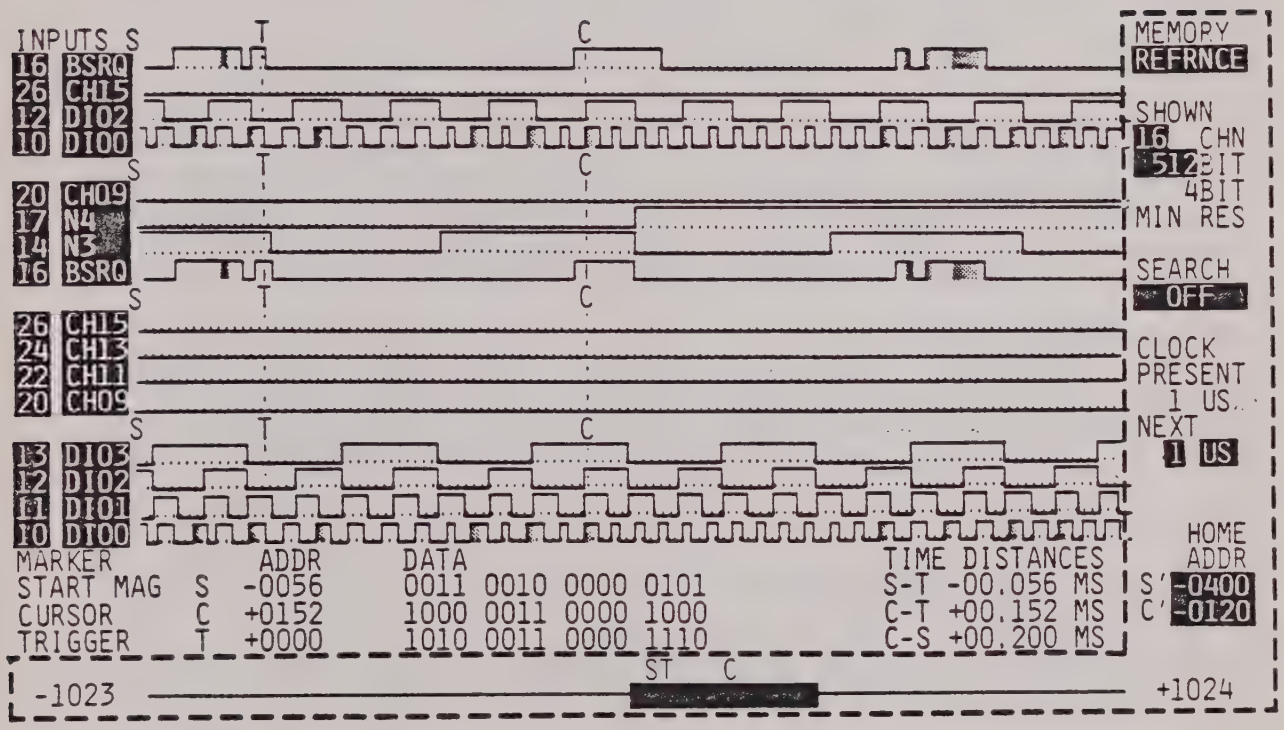


Figure 3-27 Sub-Menus In The Timing Display

a. **Raster**

The dotted line which appears under each channel is the raster for the time display. The distance between two points indicates the minimum distance in which data transitions are still represented as vertical lines. For maximum magnification the resolution is one bit exactly, so that the distance between two raster points corresponds exactly to one memory place. Since normally the internal clock is used for time analysis, if the clock rate is chosen correctly, the minimum distance of two data transitions is a multiple of this raster unit with full magnification.

Display edges can only appear at discrete places on the screen, always between two raster points. Display errors originating from this requirement no longer appear during magnification.

b. **Resolution**

Horizontal resolution in bits is the minimum distance between two data transitions on a channel which is still capable of being displayed as separate vertical lines. On the display this distance corresponds to the distance between two raster points.

c. **Unresolved Areas**

If the selected magnification is too small, then consecutive data transitions are displayed not as separate lines, but as shaded areas. This is caused by more than one transition falling within a raster unit.

d. **Cursor Line**

Line C in the timing display represents a cursor with the following functions:

1. Orientation to help determine the positions of the displayed channels on the vertical axis

2. Reading of data at cursor position

3. Determining time distances between cursor and trigger position (T) or start of magnification (S)

Line C is moved by pressing Screen key (8), followed by the LEFT, or RIGHT directional cursor keys (11). Line C is a different cursor than the one used for changing inputs in parameter fields.

e. **Trigger Line**

Line T marks the trigger position in the time display. This line also helps the user read the data of the displayed channels, time distances to the cursor line C, and to the start of magnification.

f. **"Start Magnification"**

This line is shown as a solid line only when the magnification is x 1. It marks the beginning of magnification in memory. The S line at x 1 magnification and the magnified segment beginning at this location is moved as follows:

Press SCREEN key (8), then press LEFT or RIGHT movement keys (6).

g. **Address And Data At Positions C, T, And S**

The memory addresses for C, T, and S are displayed in field 7 as identified in **Figure 3-25.** The bit of the highest value corresponds to the displayed channel in the top line. Readout proceeds from top to bottom.

h. **Time Distances Between Positions C, T, and S**

Time distances between positions C, T, and S are displayed in field 8 as shown in **Figure 3-25.** These times refer to the internal clock with the clock rate set during the recording, and are not valid for channels recorded with an external clock. The resolution with which these clock times are determined also corresponds to the internal clock rate.

i. **Recording Clock Rate**

The clock rate is given in field 9 as shown in **Figure 3-25.** This rate refers to the clock rate that was set during the recording and is valid for all the channels of the display recorded with this internal clock. The clock rate displayed under NEXT can differ from the PRESENT rate as long as no recording is done under the new setting.

j. **Orientation Scale**

The line at the bottom of the screen display, identified as field 10 in **Figure 3-25,** shows the position of the displayed segment in the entire time window. When the line is moved from the start magnification location, the light bar on the line also moves with it.

In the x 1 display, which shows the entire memory, the bar begining with S represents the beginning of the area for all magnified displays.

k. Glitch Display

If the cursor is in one of the fields for channel number selection, by entering 8 or 16, the user can choose between two types of glitch display.

1. 8-Channel Time Display. Glitches are shown as vertical lines on the signals (half the height of signal edges). Only the signal channels or also the glitch channels that go with the same signal channels can be displayed.
2. 16-Channel Time Display. Glitches appear either as shaded areas on the signals identified as 3 in **Figure 3-25** or are displayed as logical 1 at the appropriate positions on the glitch channels.

If the original channel sequence (in ascending probe and pin numbers) has been changed, related pairs of glitch and signal channels may no longer appear under each other. By switching between two types of display via the C cursor on the channel selection field the original ascending sequence is restored.

If several glitches appear one after another in the same channel, so that the distance between them is smaller than the resolution at the selected magnification level, the display changes as follows:

1. In 16-Channel Operation--Glitches which can no longer be displayed individually are shown on separately displayed glitch channels.

2. In 8-Channel Operation--Glitches appear on separate shaded glitch channels. They are no longer shown in their full number on signal channels.

In these cases, resolution has to be increased by selecting a larger magnification. If there are several glitches between two sampling clock edges, these are not caught separately.

3.4.1.2 INPUT FUNCTIONS IN THE TIMING DISPLAY

The parameter input fields around the timing display are shown in **Figure 3-28, Input Fields In The Timing Display.**

SCREEN AREA	CALLOUT NUMBER IN FIGURE 3-28
Channel Number and Mnemonics, Channel Sequence	1 and 2
Memory Selection	3
Channel Number/Glitch Display	4
Magnification/Time Window Width	5
Search Operation	6
Clock Preselection	7
Jump Addresses for Start Magnify and Cursor	8 and 9
Time Window Position	10

In order to input in these fields, first press the FIELD key (7). The parameter fields which can accept input flash. Move between the fields with cursor movement keys (6).

When SCREEN key (8) is pressed the blinking of the parameter fields stops. Then the timing display can be scrolled vertically or horizontally.

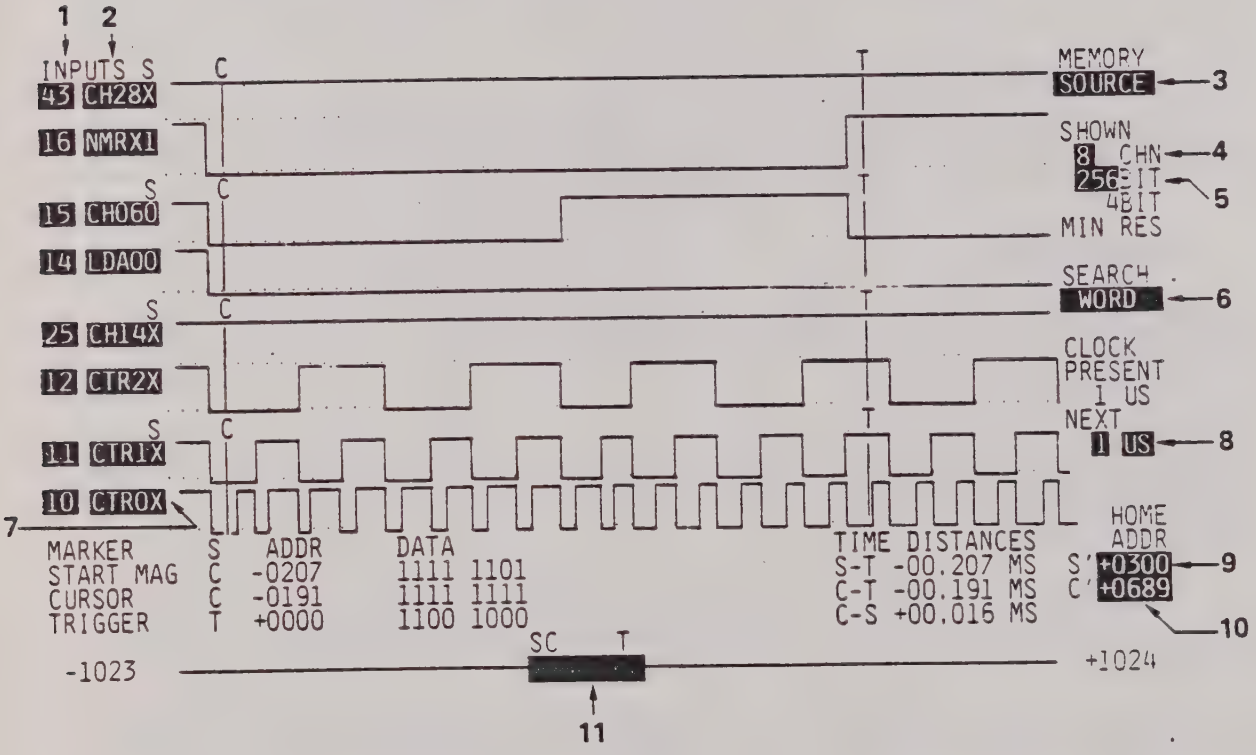


Figure 3-28 Input Fields In The Timing Display

The input functions of the timing display will now be explained.

a. **Channel Numbers and Mnemonics, Channel Sequence**

The channel numbers of all signal inputs are programmed into the KLA as follows:

First digit represents number of probe
Second digit represents the input number pin of the probe

Thus the channels of the KLA 64 are not numbered 1 to 64 but in probe groupings:
10 to 17, 20 to 27, ...80 to 87

Field 2 which is the next field after channel numbers, shows a column of mnemonics for each of the channels. These mnemonics can be default mnemonics such as CH01 to CH64, or they can be assigned by the user. A mnemonic can be input at any line in field 2 to correspond to a certain channel. Any combination of active channels can be called by mnemonics. It is permissible to call up a channel in several places at once.

Channels of probes switched off in the Configuration Menu are not displayed. Channels read with different clocks are not displayed on the same time scale. If a combination of INTERLACE and NON-INTERLACE mode is selected, than only the channels in INTERLACE operation will be displayed in the timing diagram. This is because the varying memory length between interlace and non-interlace channels make simultaneous timing display impossible. When switching between INTERLACE or NON-INTERLACE, or a combination of both, the original channel sequence is restored. The pin numbers are listed in increasing order from bottom to top.

Channels using and external clock are marked with an X between field 1 channel numbers) and field 2 (mnemonics) in the timing diagram.

b. **Memory Selection/Loading The Reference Memory**

The selection of which of the two memories should be displayed is made in Field 3 in **Figure 3-27, Input Fields In The Timing Diagram.** Either the source or the reference memory can be displayed. The setting S XOR R executes a quick optical data comparison between both memory contents. Only the differing locations are displayed as 1's. To load the source data into the reference memory, the display S ⟶ R is rolled to in field 3, then the EXECUTE key (19) is used to move the data.

Table 8 Summary Of Input Functions In The Timing Disp.

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	CHANNEL NUMBERS		10 to 17...80 to 87	0...8
2	CHANNEL MNEMONICS		Up to 4 alphanumeric characters per field	0...9 A...Z
3	MEMORY	Displayed memory	SOURCE/REFERENCE/ S XOR R	ROLL
		Data transfer	Source to Reference	EXECUTE
4	SHOWN ...CHN	Number of channels displayed	8 CHN 16 CHN	ROLL
5	SHOWN ...BIT	Number of memory locations displayed	8 channel: 64, 256, 1024, 2048 bits 16 channel: 128, 512, 1024, 2048 bits	ROLL
6	SEARCH	Search for data wrd, data equality, data inequality	OFF, WORD SRC=REF S><R	ROLL EXECUTE
7	+	Search word input	0, 1, X	0, 1, X
8	CLOCK NEXT	Clock rate of next recording	Non-interlace: 20ns...500ns Interlace: 10ns...500ns	ROLL
9	HOME ADDR. S'	jump goal for start of magnification	any address in memory positive or negative	+, -, 0...9
10	HOME ADDR. C'	jump goal for CURSOR	as in field 9 HOME = key 12	+, -,
11	---	Position of display area in memory	stepwise shift of time window width	Key (6)

c. **Channel Number and Glitch Display Control**

The selection of 8 or 16 channel time display occurs in field 4 as identified in **Figure 3-28, Input Fields In The Timing Display.** When switching between 8 and 16 channels, each time the top 8 channels of the 16 channel display are shown. If individual probes are set in the glitch operation in the configuration menu, the user can switch to glitch display via key G, as long as the cursor is in field 4. Switching to the glitch display with the G key restores the timing display to its original vertical sequence with the pin numbers increasing from the bottom of the display to the top. There are two types of glitch displays:

1. Glitch display on signal channels. In 8 channel display, glitches are marked as vertical lines one-half the height of the signal edges. In 16 channel display, they are shown as shading. This shading is similar to the one found in unresolved areas, except in the glitch display it is not due to the selection of insufficient magnification.

2. Direct indication of glitch channels. Glitches are shown as positive pulses in 16 channel display. In 8 channel display they are retained as vertical lines.

d. **Magnification/Time Window Width**

Field 5 in **Figure 3-28** indicates the number of memory places of the 2K or 4K memory depth is being displayed. The ROLL keys (9) change the time window and also change the magnification

Another way to change magnification is to input numbers 1 through 4 at all locations in the timing display where no other alphanumeric characters are provided.

e. **Search Programs**

The type of of search is chosen in field 6 of the timing display. The ROLL key brings up the choices, and if WORD is chosen, an input column for the word to be searched appears in field 7.

The search is initiated with the EXECUTE key (19). During the search the S cursor jumps to the next position where the condition being searched occurs. The beginning and the end of search areas where the search condition is fulfilled are marked with the S and the C cursors. To start the search in the next memory area, the EXECUTE key is pressed again.

If the search condition reaches the end of memory, the indication NO FURTHER OCCURRENCES FOUND will be displayed for about 5 seconds. If the EXECUTE key is pressed during this time, the search will return to the beginning of memory.

The sequence for executing a search program is as follows:

Select a Search Program
Field 6

Input A Search Word If Necessary
Field 7

EXECUTE

NO FURTHER OCCURRENCES DISPLAY

EXECUTE Or HOME Key (10) To Return To Beginning Of Memory

A search word remains on displayed and undisplayed channels, as long as it is unaltered, but a search is done only on displayed channels. As long as field 6 is on SEARCH, and not on OFF, a search can be continued at any time by pressing the EXECUTE key, regardless of whatever other functions have been executed. However, the cursor must not be on field 3, S ⟶ R when the search is to be continued. If the cursor is in field 3, (S ⟶ R) and the EXECUTE key is pressed, memory contents will be moved from source memory to reference memory.

f. Clock Setting

The rate of the internal clock can be set in either the configuration menu or in the time display in the NEXT CLOCK field. When the clock rate setting is changed in the timing display, the values for PRESENT CLOCK and NEXT CLOCK will not agree until a recording is started. The recording is based on the value displayed for the PRESENT CLOCK.

g. Jump Addresses for Start Magnify and Cursor

As an alternative to continous scroll, jump addresses for S and C can be input in fields 9 and 10 as shown in **Figure 3-28.** Then the cursors can be made to jump back and forth between originating addresses, and the input HOME addresses freely. To mark an originating position as a HOME address, the user need only press the HOME key, and the original address with be input automatically into the HOME address field.

h. **Time Window Position**

The magnified time window can be scrolled in increments of its own width (this width is displayed in field 5 of **Figure 3-28**). In order to scroll the time window, the cursor must be moved through the input fields 3 through 10, and positioned on field 11. Then either LEFT, or RIGHT key, from key group (6) can be used to scroll the window horizontally.

i. **Cursor Movement**

The cursor in the timing display can be scrolled continously with key group (11), after the SCREEN key (8) is pressed. Holding down one of the directional movement keys from key group (11) will move the cursor a few memory places. If the keys are pressed one at a time, then the S will move one memory place at a time.

k. **Moving Vertically Through Channels**

The timing display can be scrolled vertically, four channels at a time using UP or DOWN key from the key group (6), after the SCREEN key (8) is pressed first.

User selected channel sequences are retained during this scrolling procedure. However, if a change between interlace and non-interlace operation is made, or if glitch display is selected, then the user selected order of pins and probes will change to the original sequence. The numbers will be in increasing numerical order from bottom to the top of the screen.

3.4.2 DATA LIST DISPLAY

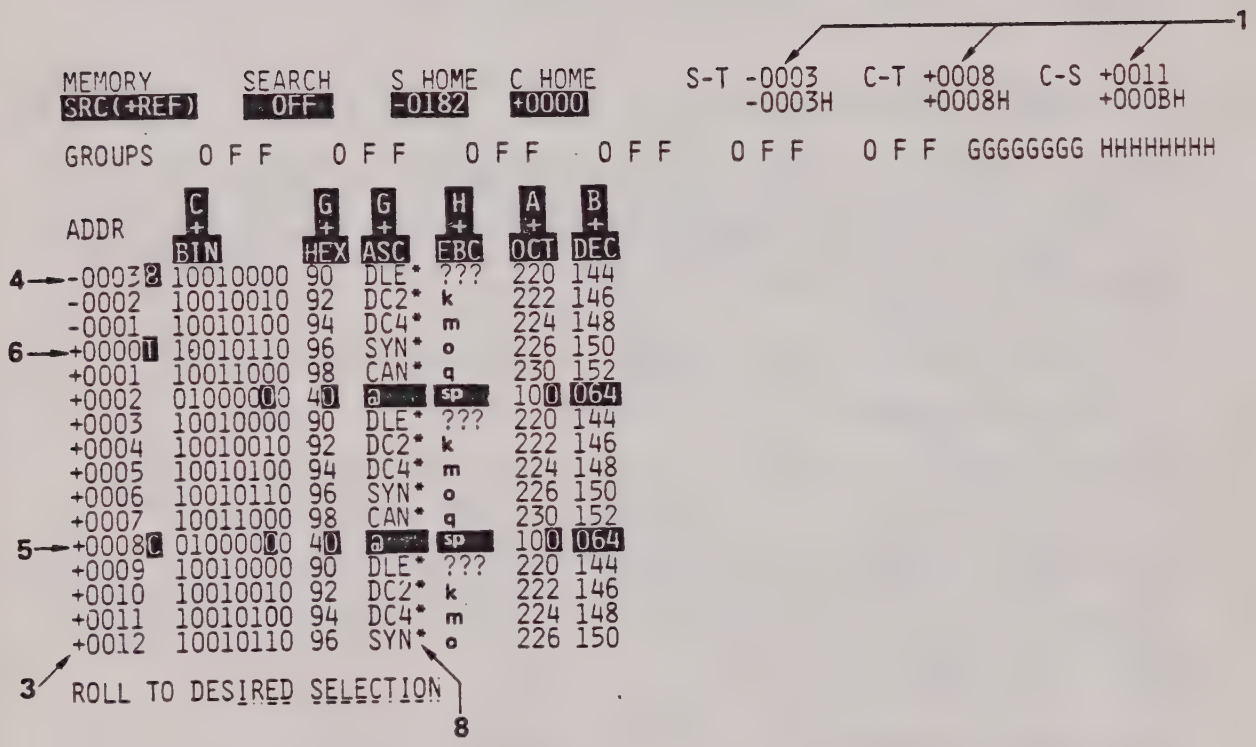
All channels of the KLA can be displayed in data list format. Channels combined into channel groups in the Trigger Word Menu are displayed as separate columns. Sequence, data format and polarity are user selectable for all columns. Cursor S for first displayed memory location, and T for trigger position along with distance indications between the individual positions are available as orientation aids. Word search capability is available for up to 16 words.

An explanation of the screen information in the data display is given first, before the screen inputs are discussed.

3.4.2.1 Explanation Of The Data List Display

In addition to the displayed data itself, the following information also appears on the KLA screen in the Data List display:

SCREEN AREA	CALL OUT NUMBER IN FIGURE 3-29
a. Distances Between Positions S, C, T	1
b. Channel Group Distribution	2
c. Memory Addresses	3
d. Marks S, C, and T	4, 5, and 6
e. During Search Only WORD, R=S, Or R><S Number Of Appearances In Memory	7
f. Data Differences In Source/Reference Memory Comparison	8



ADDR	C + BIN	G + HEX	G + ASC	H + EBC	A + OCT	B + DEC
-0003	10010000	90	DLE*	???	220	144
-0002	10010010	92	DC2*	k	222	146
-0001	10010100	94	DC4*	m	224	148
+0000	10010110	96	SYN*	o	226	150
+0001	10011000	98	CAN*	q	230	152
+0002	01000000	40	@	sp	100	064
+0003	10010000	90	DLE*	???	220	144
+0004	10010010	92	DC2*	k	222	146
+0005	10010100	94	DC4*	m	224	148
+0006	10010110	96	SYN*	o	226	150
+0007	10011000	98	CAN*	q	230	152
+0008	01000000	40	@	sp	100	064
+0009	10010000	90	DLE*	???	220	144
+0010	10010010	92	DC2*	k	222	146
+0011	10010100	94	DC4*	m	224	148
+0012	10010110	96	SYN*	o	226	150

Figure 3-29 Data List

a. **Distances Between Positions S, C, T**

S = First displayed memory position, corresponding to start magnify in the timing display.
C = Cursor, corresponding to the cursor position in the timing display.
T = Trigger position

In the data list display, the distances between these three positions are read as the number of memory places, in contrast to the timing display, where the distances between these three positions are read as time distances. The first value represents the interval as a decimal number, the second as a hex number.

b. **Channel Group Distribution**

The distribution of inputs into channel groups is selected in the Trigger Words Menu (See Section 3.3.2.2). A reminder of this distribution appears in field 2 of the Data List display. If the user wants to change the channel distribution, such a change has to be made in the Trigger Words Menu.

Channels where an X has been entered are not read in the data list.

c. **Memory Addresses**

In the column(s) identified as 3 in **Figure 3-29**, each line contains the memory address for the data read out to the right of the column.

The user is reminded that addressing in the KLA Memory starts with the trigger point as 0000, and all subsequent memory positions are numbered with positive addresses and all those preceding the trigger point have negative addresses.

d. **Markers S, C, and T**

The markers S, C, and T which appear in reverse video, next to the address column (see **Figure 3-29**) have the following meanings:

S = First Memory Position Read Out

C = Cursor

T = Trigger Position With Memory Address = 0000

e. Number Of Appearances Of Searched Event (WORD or R=S or R><S)

The number appearing in field 7 as shown in Figure 3-29, Data List indicates the number of times the searched condition was found in memory, regardless of whether one word, or a sequence of words, or data inequality between source and reference memories is searched. If a word sequence is searched, field 7 indicates the number of memory places where the complete sequence is detected.

Table 9 Summary Of The Interpretation of Data Display

NUMBER IN Figure 3-29	NAME	MEANING	EXPLANATION
1	S - T C - T C - S	Distances between trigger position T, first memory position S and cursor C	Distance in number of memory positions, decimal and hex.
2	GROUPS	Channel group distribution	As set in the Trigger Word Menu, here as a reminder only
3	ADDR	Memory Addresses	Memory addresses in decimal referring to the trigger point 0000.
4	S	First represented memory position	Corresponds to start of magnification in time display.
5	C	Cursor	Corresponds to cursor C in the timing display
6	T	Trigger	Address always at 0000
7	... OCC	Number or appearances in Memory of the searched word or event	Number of memory locations where the searched word or event was found
8		Data differences between source and reference data.	Reverse video display when data unequal

f. Data Differences Between Source And Reference Data

Referring to **Figure 3-30, Input Fields In The Data List**, field 1 is where the memory equality/inequality search is input. If MEMORY = SRC(+REF) is selected, source data is in reverse video when there is no data equality between source and reference data. If MEMORY = REF(+SRC) is selected, reference data is in reverse video when there is no data equality between source and reference data.

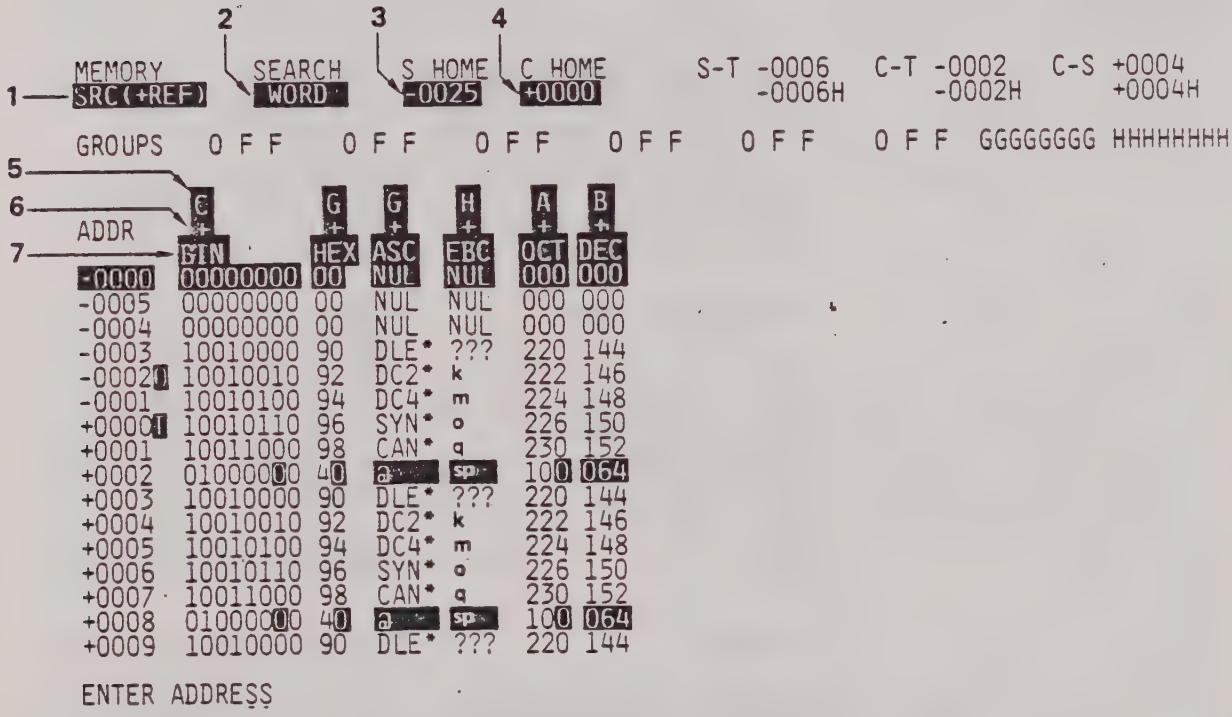


Figure 3-30 Input Fields In The Data List

3.4.2.2. Input Functions In The Data List

Inputs in the data list are entered via the menu format, and the callout numbers for the input fields of the Data List are shown in **Figure 3-30 Input Fields In The Data List.**

SCREEN AREA	CALLOUT NUMBERS IN FIGURE 3-30
a. Memory Selection	1
b. Searches	2
c. Jump Addresses for C and S	3 and 4
d. Channel Group	5
e. Polarity	6
f. Data Format	7

If WORD search is selected by rolling in field 2, and the cursor is moved away from field 2 after this selection is made, then additional input fields appear. These are shown in **Figure 3-30, Word Or Word Sequence Search In Data List.**

SCREEN AREA	CALLOUT NUMBER IN FIGURE 3-31
g. Address Or Trigger Word Name/Number	8
h. Data Input For Search Word	9

Inputs are made in the FIELD mode, that is, with the FIELD key (7) pressed, so that parameter fields are blinking. Addition or removal of channel groups is also done while in the field mode.

After the parameters are input or changed, if the user needs to scroll thorugh the data list, SCREEN key (8) is pressed and the blinking of the parameter fields is turned off. When the KLA is in the SCREEN mode, screen movement and cursor control are provided via the key group (6).

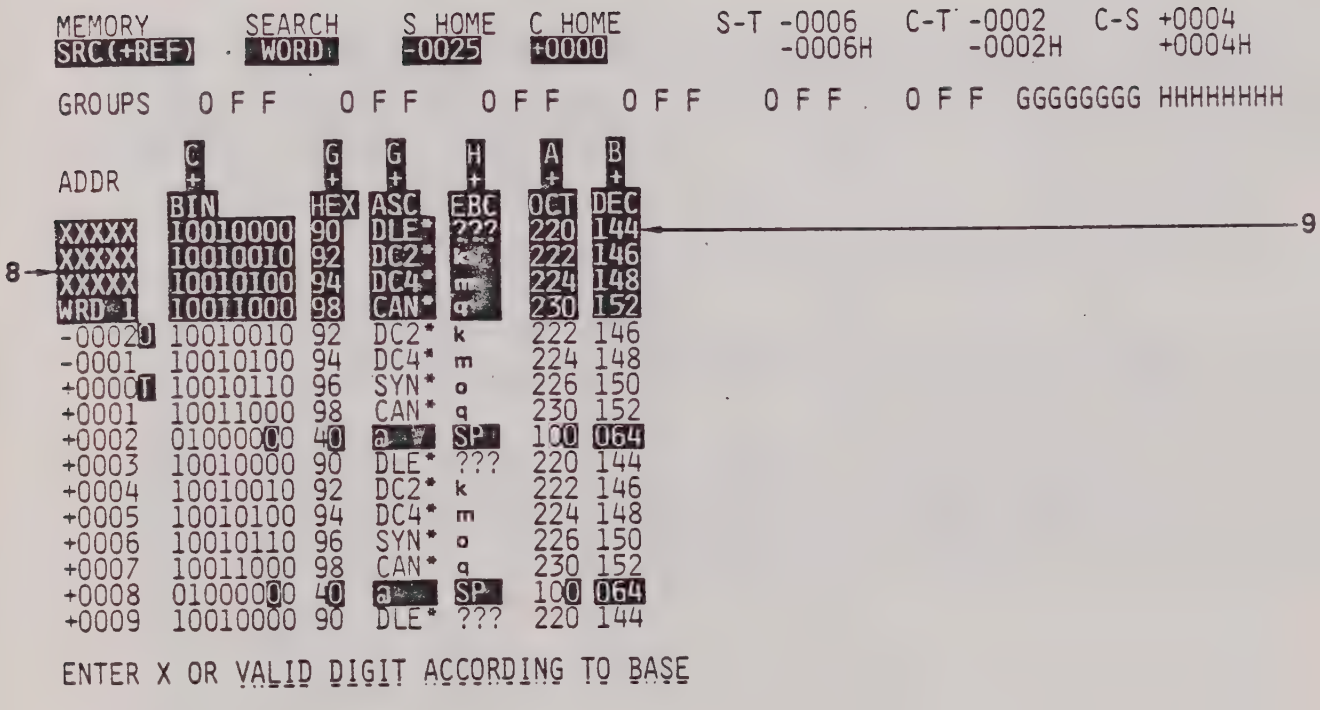


Figure 3-31 Word Or Word Sequence Search In Data List

Table 10 Input Functions In The Data List

FIELD	NAME	REMARKS	SETTINGS	INPUT KEY
1	MEMORY	Memory Selection	SOURCE REFERENCE REF(+SRC) SRC(=REF)	ROLL
		Data Transfer	SRC ⟶ REF	EXECUTE
2	SEARCH	Search: WORD WORD SERIES DATA EQUALITY DATA INEQUALITY	OFF WORD SRC=REF S><R	ROLL EXECUTE
3	S HOME	Jump Address for beginning of data list	Any address + or - in memory	+, -, 0...9 HOME key
4	C HOME	Jump Address for Cursor	Same as in Field 3 above	Same as 3 above
5		Channel Group	A...H	ROLL
6		Polarity	+, -	+, -. ROLL
7		Data Format	HEX., ASC., EBC., BIN.,OCT., DEC.	ROLL
8		When +0000 appears input memory address When XXXXX appears input trigger wrd	+, -, 0...9 0...9, A...Z	
9		Data Input for search word[1]	0...F, X for HEX 0,1,X for BIN 0...7, X for OCT 0...9, X for DEC	

NOTE TO TABLE 10

1 Input in ASCII or EBCDIC is not possible, but data can be displayed in these formats after being input in another format.

Table 11. Additional Functions In The Data Display

FUNCTION	TYPE/MEANING	SETTINGS	INPUT KEY
Position Start (S) On Data List	Continous Scroll	SCREEN	keys (6) up/down
	Horizontal scroll by 16 Memory places	SCREEN	keys (6) left/right
	Jump between two addresses	Any setting	Home (10)
Position Cursor (C)	Continous Scroll	SCREEN	Keys (11) left/right
	Jump between two adresses	Any setting	HOME (12)
Add New Data Columns	Replicate a column next to itself 1, 2	FIELD	key (17) ADD
Remove Data Columns	Column Groups On Right get deleted 2	FIELD	DELETE key (18)

1 Newly added group will have the same channel grouping, polarity and data format. Column display format can be changed after replication, but not while being added.

2 Cursor must be on channel group, polarity or data format field to duplicate the column.

Now these input fields and user functions will be explained further. All field numbers referred to are shown in Figure 3-30 and Figure 3-31.

a. **Memory Selection/Loading Of Reference Memory**

When field 1 MEMORY is selected, the user can read out Source or Reference Data in the Data List Display. All the data differences between the two memories is highlighted in reverse video with the settings SRC(+REF), where Source is reverse video, and REF(+SRC), where Reference is in reverse video.

In the setting SRC ⟶ REF, the EXECUTE key will enter the data from the present source memory into the reference memory. If the cursor is in the SRC ⟶ REF field, it can be moved out of this field only by pressing the EXECUTE key.

b. **Search Programs**

The two memory areas, that is, source memory and reference memory, can be searched for data equality/inequality or for any data word, or word sequence. This search is called up in field 2 SEARCH, and is executed by pressing the EXECUTE key (19) repeatedly if necessary.

The beginning and the end of the memory areas where the search is being done are designated by the S and C cursors, where S is the beginning of the search area, and C, the end of the search after the last detection of the searched word.

If there are several occurrences of the search word, pressing the EXECUTE key repeatedly will find each successive place. At the end of all occurrences of the search conditions the screen will display the message "NO FURTHER OCCURRENCES FOUND" for about 5 seconds. If the EXECUTE key is pressed during this five seconds again, the search will start over at the beginning of memory. If the HOME key is pressed during this time, the search will resume at the address S HOME. This is one case where the pressing of the HOME key does not initiate the exchange of the starting and HOME addresses.

To Input or to Recall Search Words or Word Series:

1. Select WORD setting in in field 2
2. Move the cursor down with key (6)
3. Input fields for up to 16 words will appear.

To Recall A Search Word Series Already Input:

1. Select WORD setting in field 2
2. Move cursor down with key (6)
3. Previously input word(s) will appear

To Search For Two Words Separated By An Interval:

1. The interval can be no more than 16 memory places.
2. Set X = don't care for all the words in between the two.
3. EXECUTE search.

The basic sequence for all search programs proceeds as follows:

Select Search Operation
Field 6

Input Search Word If Needed
Field 7

EXECUTE (key 9)

IF "NO FURTHER OCCURRENCES"
PRESS EXECUTE OR HOME key (10)

c. **Jump Addresses**

Setting jump addresses between two memory locations is an alternative to continuous scrolling of the screen. The S cursor is set to the address at the beginning of the time display, and the C cursor is the location at the end of the search area. The jump addresses are set in fields 3 and 4. In setting these addresses, it does not matter whether the polarity sign (+ or -) or the digits are entered first. The polarity does not need to be entered unless it is being changed. Each time the HOME key is pressed the display jumps back and forth between the beginning and the ending addresses. Each cursor has its own HOME key; the S cursor is set with HOME key (10), and the C cursor is set with the HOME key (12).

d. **Channel Group**

The channel groups are first defined in the Trigger Word Menu. In the data list they can be called up in field 5 (**Figure 3-30, Input Fields In The Data List**). The channel groups can be called up by the ROLL key or they can be directly entered as the letter A...H. The distribution of channel groups cannot be altered in this menu, it is here as a reference or reminder only. All changes to channel groupings have to be made by returning to the Trigger Word Menu.

e. **Polarity**

For a non-inverted display select (+) in field 6. For an inverted display select (-). Either sign can be rolled to with key (9), or directly input via the keyboard.

f. **Data Format**

The data format is selected in field 7 with the ROLL keys (9). Binary, hexadecimal, octal, and decimal formats are available for input and display both. ASCII and EBCDIC formats can be displayed, but are not available for input. Distribution of the bits belonging to one symbol from all the bits of a channel group proceeds from the least significant bit to the most significant bit, left to right. Leading zeroes are supplied if the symbol is smaller than the field width.

1. ASCII Display

   If the channel group consists of 5 channels or fewer, the leading zeroes missing for the 7-bit ASCII code will be supplied.
   For a group that is 6 bits, 20 hex will be added to each 6-bit word (binary 0010 0000). The ASCII symbols from the table will then correspond to printable numbers.
   For 7 or more channels, the data corresponds directly to the ASCII table (7 bits). If the width of the group amounts to 8 or more channels, only the 8 least significant bits are evaluated; if the bit "2 high 7" = 1 then an asterisk (*) appears next to the corresponding symbol.

2. Bit Combinations Not Present In EBCDIC Code

   If the bit combination to be displayed is not present in the EBCDIC code table, "???" appears at this place in the data list.

3. X In Channel Group Distribution

   If individual channels are set to "X = don't care", by entering X during channel group distribution selections in the Trigger Word Menu, then those bits are accepted as 0 during readout in all formats except binary. In binary display, those bits are represented as "X".

g. **Search Word Callup Or Input**

When WORD search is selected in field 2, as soon as the cursor is moved away from field 2 with cursor key (6), a new parameter field identified as 9 in **Figure 3-31, Word Or Word Sequence Search In Data List** appears. From 1 to 16 words can be entered in field 9. Three different types of input are available for entry:

1. Direct input via alphanumeric keyboard
2. Callup of a trigger word as search word at that location. This callup is made in field 8 shown in **Figure 3-31.**
3. Callup of data from any location in memory as a search word. This callup is made in field 8 shown in **Figure 3-31.**

1. **Direct Input Of A Search Word**

Input is made in the same data format as the existing column. Input in ASCII or EBCDIC is not possible. If that channel group is in ASCII or EBCDIC, first it must be called up in another format before direct keyboard entry is possible. The parameter field for changing formats is at the top of each column. Format is changed by moving the cursor to the parameter field, pressing FIELD key (7), rolling through the available formats in that parameter field to one of the formats which allow keyboard entry. When the cursor is moved away from the parameter field, the new format is set.

If individual channels have been turned off by entering X in the Trigger Words Menu, then no inputs can be made in those channels in the Data List. The bits which belong to the turned off channels are ignored as input (accepted as zero).

2. **Callup Of A Trigger Word As Search Word**

In field 8 of **Figure 3-30**, a trigger word from the Trigger Word Menu can be input at any location where XXXXX occurs. To display XXXXX at a location use the ROLL key, then enter the number or the mnemonic for a trigger word. The trigger word will appear in that location as a search word. When the cursor leaves the area, the trigger word will disappear, but the data will remain for the search.

3. **Callup Of Data From Memory As A Search Word**

In field 8 of **Figure 3-31**, a memory address can be input as a search word, at any location where +0000 occurs. To display +0000 at a location, use the ROLL key, then enter the memory address. The data at this address in the memory is then called up as search word at that line. When the cursor leaves the memory address input field, the address disappears, but the data will remain for the search.

Screen Move In The Data List

The data list can be scrolled continously, both horizontally and vertically using movement keys (6). First, press the SCREEN key (8). Then use the up and down cursors to move continously or one step at a time. If horizontal movement keys are pressed, the data display will scroll 16 memory places in each direction. If at any time during the scrolling, parameters are to be input, or changed, then press FIELD key (7). The parameter field will start to blink when in the FIELD mode, indicating that data can now be input.

i. **Addition Of Columns In The Data Display**

To add a new column, set the cursor at the head of the first column that you would like to duplicate. Then press the ADD key (12). The new column will appear to the right of the first column where the cursor is positioned, and it will have the same polarity, channel grouping and data format as the first column. These can be later modified. The advantage of this feature is that a data column can be duplicated six times, then the format changed to any or all of the available display formats for trouble shooting. For example, glitch detection is possible only in the binary format.

j. **Removal Of Columns In The Data Display**

Set the cursor at the head of the column to be removed, in the channel group, polarity, or data format field. (Fields 5, 6, or 7 in **Figure** 3-30). Then, press the DELETE key (18). The column will disappear from the data display. If the cursor is in fields 1 through 4 in **Figure** 3-29, then the column farthest to the right will be erased.

3.5 SCREEN MESSAGES

3.5.1 SLOW CLOCK

This message appears on the screen when several different conditions are present.

a. When no clock is present at a clock input (J0, J1, K0, K1)
b. When the clock frequency is less than 10 Hz.
c. When the clock frequency is actually greater than 10 Hz, but the clock qualifier conditions are filled at a rate slower than 10 Hz.
d. When several clocks are OR connected, and only some of these clocks are too slow, or the data probes that go with some of them are turned off. Therefore, when several 16-channel boards are connected in arrangement, the unused probes in the OR connections should be turned off.

3.5.2 TRIGGER TRACE ACTIVE

This message is displayed from the beginning of sampling or recording until all the trigger conditions have been fulfilled.

3.5.3 TRIGGER DELAY ACTIVE

This message is displayed at the end of TRIGGER TRACE ACTIVE, until the trigger delay has run out.

3.5.4 TRIGGER FOUND

This message is displayed after the trigger conditions are fulfilled and the trigger delay has run out.

3.5.5 KEYBOARD BREAK

If a running recording is interrupted by the keyboard RUN/STOP key before the trigger conditions are met, the trigger point address 0000 is placed at the end of the memory to show that this recording was interrupted and did not end at the time set in the trigger conditions. At this time, the screen displays the KEYBOARD BREAK message.

3.5.6 PERMANENT DISK ERROR

This message is displayed when there is a read/write error. If repeated read attempts do not get rid of the message, a faulty diskette may be involved. See also Treatment Of Read/Write Errors under **Section 3.3.3.2 Store/Recall Menu.**

3.6 MIXED ANALYSIS: SIMULTANEOUS RECORDING WITH DIFFERENT CLOCKS

Simultaneous recording with different clocks is applicable whenever simultaneous analysis of two or more systems with different system clocks is needed. The interaction of hardware and software in a single processor system, as well as the interaction between microprocessors in a multiprocessor system can be analyzed with this type of recording.

Parallel recording with different clocks which are synchronous to each other, is used for analyzing data carried on the different channels of the logic analyzer.

3.6.1 SIMULTANEOUS TIME/DATA ANALYSIS

In microprocessor based systems, problems with interactions between hardware and software can be detected best by simultaneous time/data analysis of the problem data area. With this type of simultaneous analysis, the internal synchronous clock of the logic analyzer is used for the time analysis, and the external asynchronous clock of the system is used for the data list. Even though the analysis is simultaneous, because of the differing clocks, data from the same memory location does not appear at the same point in time, except at trigger points. Therefore joining the two sets of data requires triggering accurately on the problem area, usually on the address/data bus of the processor.

3.6.2 TRIGGERING ON TIME AND DATA CHANNELS

When recording with two or more clocks asynchronous to one another, it is not possible to trigger on time and data channels simultaneously. Since the trigger point is the only time correlation point between data and time recordings, sometimes it is not enough to trigger separately on the different channels. Then, both the internal and the extenal clocks are selected as master clocks in the Configuration Menu. Individual trigger words and trigger levels are assigned to the two clocks, to allow triggering alternately on different trigger levels, and on time and data channels.

3.6.3 SIMULTANEOUS DATA ANALYSIS WITH DIFFERENT CLOCKS

When recording with several external clocks, there are two possibilities. First, the clocks can be synchronous to one another, that is, the recordings are made on the same clock, or the same clock is being read on different edges on different channels. Alternately, the recording clocks can be asynchronous to each other, when two or more subsystems are clocking asynchronously to one another. An example of this is a multiprocessor system.

3.6.3.1 Recording With Clocks Synchronous To One Another

If the data being recorded on different channels is tied to subclocks derived from a common clock, or it is being clocked on different edges of the same clock, then individual channel groups are read simultaneously with several clocks that are synchronous to one another. A similar case is when different channel groups are recorded with the same clock, which has been differently qualified for each of the channels. Simultaneous analysis with synchronous clocks must use Data Qualified Recording. The following basic guidelines are to be followed. There are no restrictions on triggering.

a. Only one master clock needs to be defined.

b. Data sampling is set at the same point for all channels. Data belonging to a trigger word will appear at the same point even though it is captured by different clocks.

c. The data sampling must start with the first clock of a cycle. Since all parts of the data word are present at the starting point, this clock must be set as the master clock.

d. Data recording must be done with Data Qualified Recording using the clock of memory board 0, which is clock J0. The data which appears first in the recording cycle is sampled with probes 1 and 2, and the clock J0 which goes with them. Change the polarity of the probe inputs if necessary.

3.6.3.2 Recording With Clocks Asynchronous To One Another

To capture the interaction between different microprocessors in a multiprocessor system, data has to be recorded with the individual clock of each microprocessor. These clocks are asynchronous to one another, and present the following problems in recording:

a. The only reproducible time reference point between data at the same memory address, which is recorded asynchronously on different channel groups, is the trigger point.

b. Simultaneous triggering between channel groups read in synchronously, and asynchronously is not possible.

c. In order to trigger on several channel groups which are recorded asynchronously on several levels, the recording clock belonging to each trigger level has to be assigned as the master clock to that trigger level.

The availability of two master clocks which can be assigned to different trigger levels means that direct triggering is possible on two different trigger levels separately. A certain location in the program of the first microprocessor can be isolated first. Then, the actual trigger event is searched for in the program of a second processor in the following trigger levels.

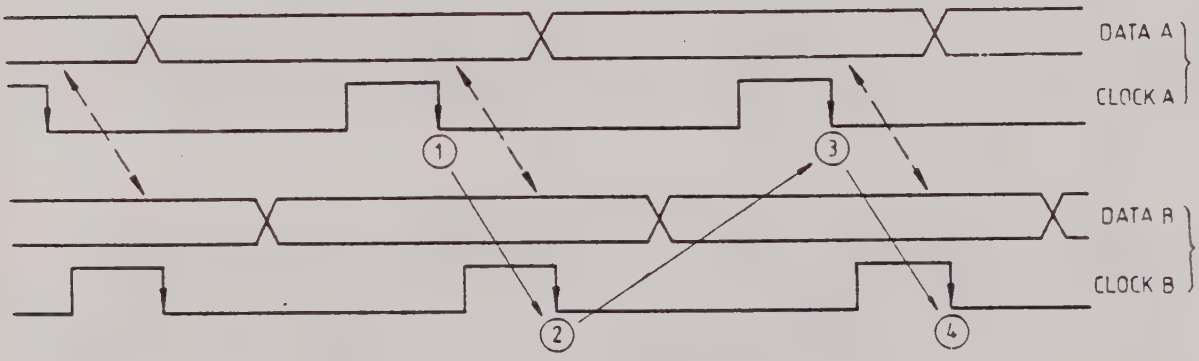


Figure 3-32 Recording With Several Synchronous Clocks

3.6.3.3 Demultiplexing a Bus during Recording

If data on a multiplexed bus is to be demultiplexed during recording in order to be read parallel on different channel groups, then the signals to be demultiplexed should be connected to each of the channel groups with several probes. The actual demultiplexing is done by appropriate clock choice for individual channel groups, or by suitable clock qualifying.

Example: **Demultiplexing The Data/Address Bus For The 8085**

To read the data and addresses of the 8085 in parallel from several channel groups, two probes should be connected to address signals AD0...AD7.

Reading of addresses on probes 1 and 2 proceeds with the negative edge of the ALE signal. The clock for both probes is -J0.

The data which is to be read parallel to AD0 to AD7 occurs at the positive edges for the signals WR, RD, and INTA; these three signals are OR'ed to each other during the clock setting for data channels. Therefore, these three signals must be connected to the clock inputs J1, K0 and K1 with necessary changes in the ARRANGEMENT (48 channels/16 channels in the Configuration Menu setting). The actual data is connected at probe 3; probe 4 is used to record the status signals. Probes 5 through 8 can be used for reading additional signals, but only with the clock sampling the additional data.

This connection is applicable when the 8085 is directly connected to the standard KLA probes. If optional personality adapters are used, the channels belonging to probes 5 though 8 remain available for any clock setting, and are not limited to the clocks sampling the data being recorded by those channels.

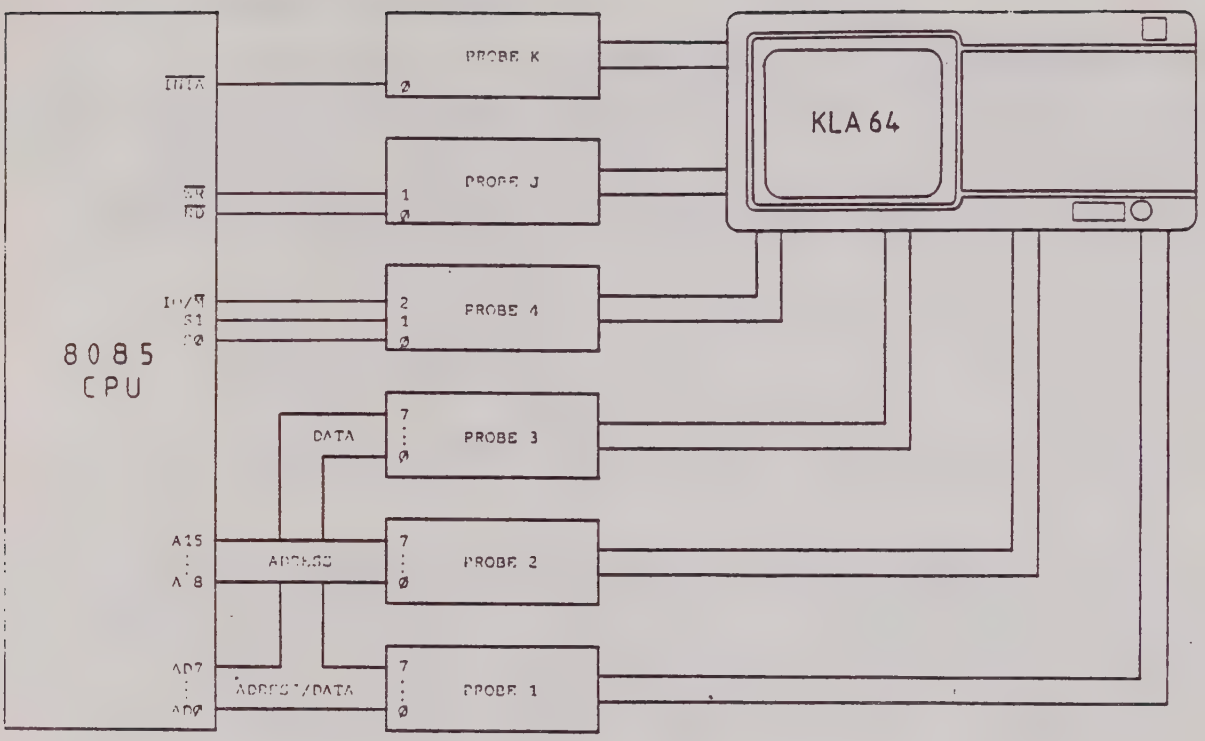


Figure 3-33 Logic Analysis In A Multiprocessor System

Connections between the 8085 system and the KLA

Address Bus signals AD0 ... AD7 connect to Probe 1 and Probe 2
Data Bus signals AD0...AD7 connect to Probe 3
Status signals IO/M, S1, S0 connect to Probe 4
ALE signal connects to Probe J pin 0. Set clock edge as -J0
WR signal connects to Probe J pin 1
RD INTA signals connects to Probe K pin 0, and Probe K pin 1 respectively.
Clock edge settings: +J1, +K0, +K1

Arrangement 48 channels/16 channels

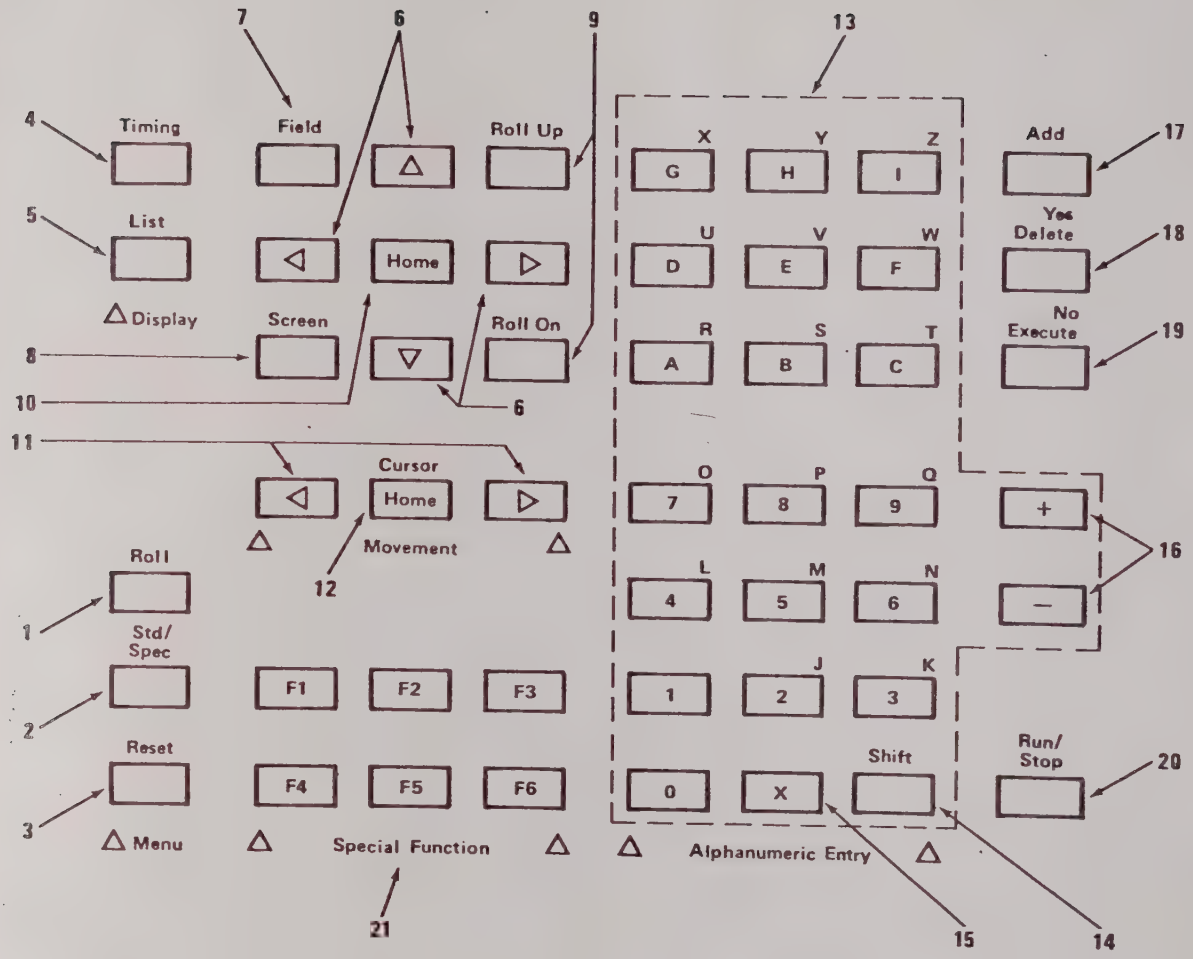


Figure 3-34 KLA Keyboard

CHAPTER 4

THEORY OF OPERATION

4.0 OVERVIEW

The Logic Analyzer hardware of the KLA is built up of modular boards which are independent of the associated microprocessor. The interface to the microprocessor is a general 16-bit parallel interface. The logic analyzer hardware consists of four different boards. These are:

1. Clock production and control . . . . . Time Base and Clock Qualifier board
2. Data recording . . . . . Data memory board
3. Trigger sequence control . . . . . Trigger sequence controller
4. Time measurement . . . . . Time measurement board

4.1 LOGIC ANALYZER BOARD FUNCTIONS

The logical function of the boards and their I/O signals are described in this section to simplify understanding of the schematics in Chapter 7, but does not explain functions down to the gate level. The board names are abbreviated as follows:

Time Base and Clock Qualifier Board	TBQ (board 312)
Data Memory Board	DMB (board 311)
Trigger Sequence Controller	SEQ (board 313)
Time Measurement Board	TMB (board 314)

The designations and signal names in **BOLD** refer to **Figure 4-1, Blockdiagram Of The KLA Hardware**, or to the schematics in Chapter 7.

4.1.1 MOTHERBOARD (BOARD 316)

The **MOTHERBOARD** has the boards in double Europa format. There are seven 64-pin connectors on the motherboard. The following boards are plugged to the motherboard:

1 TBS board (312)
1 SEQ board (313)
4 DMB boards (311)
1 TMB board (314)

A bus is assigned to each two connectors. The **A BUS** is a relatively slow TTL bus. The microcomputer has access to all registers and memory of the logic analyzer hardware over this bus (controller bus).

The **B BUS** is a high speed ECL bus (frequency 100 MHz). During a recording or trigger search, communication between boards takes place over this bus.

4.1.2 TIME BASE AND CLOCK QUALIFIER BOARD (TBQ BOARD 312)

The time base and clock qualifier board, TBQ, occupies the uppermost plug position on the **MOTHERBOARD**.

The TBQ contains the interface to the microcomputer and the central clock requirement of the logic analyzer hardware.

Connection to the microcomputer is with a 50-pin flat cable, which is directly plugged into the TBQ.

The TBQ generates clocks either from its internal time base or from external recording clocks.

4.1.2.1 Board Clocks

Each of the four data memory boards (DMB board 311) has its own independent board clock. This clock is derived either from the internal time base or from external clocks:

CL0, CL1, CL2, CL3.

For the trigger delay counter on the trigger sequence controller (SEQ board 313) these clocks are available on separate circuits:

SCL0, SCL1, SCL2, SCL3.

Selection of internal or external clock for the board clocks is through a control register loaded from the microprocessor.

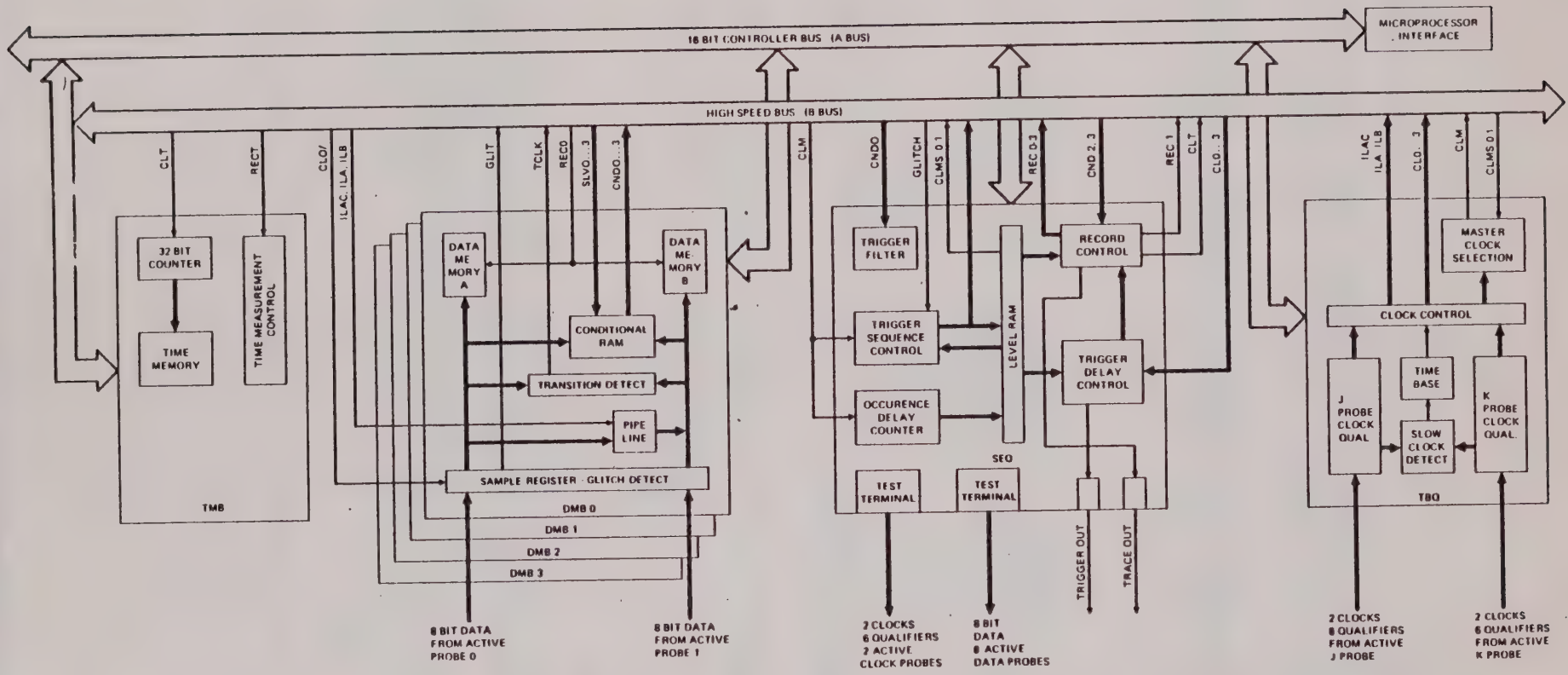


Figure 4-1 Blockdiagram Of The Logic Analyzer Hardware

4.1.2.2 Master Clock

The TBQ supplies a master clock for the trigger sequence controller (SEQ board 313):

CLM

Trigger search is executed with this clock. The master clock is selected from one of the four DMB clocks. Selection is with two signals from the SEQ: CLMS0, CLMS1.

4.1.2.3 Time Base

The internal time base supplies a stable quartz clock of 500 msec maximum, (2 MHz) to 10 nsec minimum (100 MHz) in increments of 1, 2, or 5. In addition, two clocks of constant frequency are produced:

CL10	A 10 nsec clock for processing time measurement on the SEQ
CL100	A 100 nsec clock for generating test patterns for PROBE TEST TERMINALS on the SEQ.

4.1.2.4 Interlace Mode

When recording with the maximum time resolution of 10 nsec, the data memory boards, DMBs, must be in Interlace Mode (see 4.3.2). The interlace module supplies three signals for this mode of operation:

ILAC, ILA, ILB

In the interlace mode, ILAC blocks the board clock, and the ILA and ILB clocks are released. ILA and ILB have half the frequency of the board clock, and are 180 degrees out of synch. Interlace mode is possible only with the internal clock. Two groups of DMB's (DMB0 and DMB1, DMB2 and DMB3) can operate independently of each other in Interlace Non-interlace mode. These signals can be doubled on the bus:

ILAC1, ILA1, ILB1
ILAC2, ILA2, ILB2

Interlace mode is set through a control register loaded from the microprocessor.

4.1.2.5 External Clocks

Two clock probes can be connected to the TBQ. The clock probe is mechanically and electrically identical to the 8-channel DATA PROBE (see 3.1). Thus, two clocks and six qualifiers, assigned to these same clocks are brought in with each probe.

The clock probes are designated J PROBE and K PROBE. The following configuration results:

Probe Bit	J PROBE	K PROBE	Function
0	J0	K0	Clock
1	J1	K1	Clock
2	J-Qual 2	K-Qual 2	Qualifier
3	J-Qual 3	K-Qual 3	Qualifier
4	J-Qual 4	K-Qual 4	Qualifier
5	J-Qual 5	K-Qual 5	Qualifier
6	J-Qual 6	K-Qual 6	Qualifier
7	J-Qual 7	K-Qual 7	Qualifier

Adjacent external clocks can be OR'ed. OR'ing can extend over two, three or all four clocks, and is set with a control register loaded from the microprocessor.

For each external clock, the positive or the negative edge can be qualified independently, with six assigned qualifiers:

Clock	Qualifier
J0	J-Qual 2 to J-Qual 7
J1	J-Qual 2 to J-Qual 7
K0	K-Qual 2 to K-Qual 7
K1	K-Qual 2 to K-Qual 7

Qualification of the clock edges proceeds from the clock qualifier RAM, loaded from the microprocessor.

Period length of the external clocks is checked by the slow clock detection circuit. If period length is longer than 100 msec (which is the case if no clock is connected), a flag is set that can be read by the microprocessor.

4.1.3 DATA MEMORY BOARD (DMB BOARD 311)

The data memory boards DMB can occupy connector plug positions 3, 4, 5 and 6 on the MOTHERBOARD.

The DMB contains all circuits for recording and storing 16 data channels, and for obtaining trigger conditions. Depending on the KLA configuration, 2 to 4 DMBs are built into each device. Signal designations, which are differentiated only by plug index 0...3, are designated as XXXn where n = 0...3.

4.1.3.1 Data Input In Non-Interlace Mode

Two 8-channel DATA PROBEs can be connected to each DMB. Thus, in the non-interlace mode, a 16-bit wide data stream can be recorded by each DMB. In the input register of the DMB, the 16 channels are sampled with the board clock CLn (up to 50 megasamples/sec maximum) and are stored in the 2K data memory.

4.1.3.2 Data Input In Interlace Mode

In Interlace Mode, the channel number of the DMB is reduced from 16-bits to 8-bits, but the memory depth is doubled from 2K to 4K. Only the channels of the lower DATA PROBE are recorded. The sample rate then can reach 100 megasamples/sec.

Interlace Mode is controlled by the ILACn, ILAn and ILBn signals, which are produced on the TBQ.

Interlace Mode is possible only with the internal clock!

4.1.3.3 Conditional RAM

While the data stream is being sampled, four independent trigger words can be searched. To do this, the data word sampled is set as the address for the conditional RAM. Output to this conditional RAM is 4-bits wide. Each trigger word searched produces a condition bit:

CND0, CND1, CND2, CND3

The logic analyzer hardware has 16 trigger levels available to it. In each trigger level, another set of four trigger words can be searched. The trigger sequence controller SEQ informs the DMBs, via four address circuits, of the trigger level in which the search is ongoing at the moment. These four address circuits are:

SLV0, SLV1, SLV2, SLV3

The address circuits SLV0...3 are additional inputs of the conditional RAM.

The condition bits CND0...3 are ORed on the B BUS with the condition bits of the other DMBs and passed on to the SEQ for evaluation. Only when a condition bit is "true" on all DMBs is the condition bit also "true" on the B BUS. This means that a trigger word can be recognized in its full width (all channels).

The conditional RAMs are loaded from the microcomputer.

4.1.3.4 Glitch Detector

A glitch is defined as more than one signal transition within a sample period on a data channel.

Glitch mode can be set individually for each DATA PROBE. Of the 8 channels of the probe in glitch mode, 4-bits (channels 0, 2, 4, 6) are used for data recording, and 4-bits (channels 1, 3, 5, 7) are used for storage of glitch information.

In addition, when a glitch appears, the trigger signal

GLIT

is produced, is ORed on the B BUS with the GLIT signals of the other DMBs and is made available to the SEQ for evaluation. The GLIT signal is always "true" when a glitch appears on any data channel of a DATA PROBE operating in glitch mode.

Glitch mode is possible only in non-interlace mode.

4.1.3.5 Transition Detector

The transition detection mode can be set individually for each DATA PROBE. During transition detection, all 8 channels of the DATA PROBE are monitored for data transition.

If a transition appears on one or more channels, the signal

TCLK

is produced. On the B BUS, it is OR'ed with the TCLK signals of other DMBs and is made available to the SEQ for evaluation. The TCLK signal is always "true" when a transition appears on any channel of a DATA PROBE operating in transition detect mode.

4.1.3.6 Record Control

Acceptance of the data sampled in the input register, into data memory can proceed in three types of recording:

1. Normal recording
2. Data qualified recording
3. Transition recording

Acceptance is controlled dynamically by the **RECn** signal. **RECn** can be produced individually for each **DMB** by the record controller on the **SEQ**.

In the normal recording mode, **RECn** is "true" during the entire recording. After the trigger delay counter has run on the **SEQ**, the recording is blocked when **RECn** is false. Normal recording is possible in interlace as well as in non-interlace mode.

In data qualified and transition recording modes, **RECn** is true during the recording, only if data qualification or a transition appears. Then, the sampled data will be taken into data memory. Completion of the recording is the same as for normal recording.

Data qualified recording and transition recording are possible only in non-interlace mode.

4.1.3.7 Data Memory

The data memory on the **DMB** is organized in two groups, each 8-bits wide and 2K deep.

In non-interlace mode, both groups operate in parallel. Cycle time is determined by the board clock **CLn**, and will operate up to 20 nsec. The data memory is configured for a 16 channel x 2K memory, with a maximum sample rate of 50 megasamples/sec.

In interlace mode, both groups operate 180 degrees out of phase, with a minimum cycle time of 20 nsec each. The **ILAn** and **ILBn** clocks control the memory. Inputs of both groups are switched in parallel. The data memory is configured for a 8 ch x 4K memory with a maximum sample rate of 100 megasamples/sec.

4.1.4 TRIGGER SEQUENCE CONTROLLER (SEQ BOARD 313)

The trigger sequence controller **SEQ** occupies the second connector from the top on the **MOTHERBOARD**.

The SEQ has central control of the trigger search and recording of measurement data on the DMSs. The SEQ contains two function blocks for this:

1. Sequence controller
2. Record controller

Control of the SEQ proceeds from conditions produced by the DMB.

All reactions and decisions of the SEQ are made by the master clock CLM, which is provided by the TBQ.

In addition, outputs for TRIGGER and TRACE, and test terminals for DATA PROBES and CLOCK PROBES are installed on the SEQ.

4.1.4.1 Sequence Controller

The sequence controller function block consists of:

1. Trigger filter
2. Occurrence counter
3. Level counter
4. Level change control
5. Level RAM

The sequence controller reacts at the time of the master clock to the signals:

CND0, CND1, GLIT

The sequence controller checks trigger search in 16 physical trigger levels maximum.

The condition bit CND0 allows jumping to another trigger level.

The condition bit GLIT alternates with CND0. GLIT can be released from the level RAM by software in individual trigger levels via the signal GLITEN.

In each trigger level, the condition bits CND0 and CND1 are checked simultaneously. If they appear simultaneously, CND1 has priority over CND0. Then, an unconditional jump to another trigger level is executed.

4.1.4.2 Trigger Filter

Time validity of the condition bits CND0 and CND1 is evaluated by the trigger filter. The user can set the system so that a condition bit between 1 and 15 master clocks C/M must be constantly true before it is accepted for the duration of a master clock period. This suppresses triggering on glitches.

The trigger filter can be set for each trigger level and is stored in the level RAM. The function of the trigger filter can be switched in and out of the level RAM separately in each level with the signals FIL0EN and FIL1EN.

With the signal CND0, the trigger filter has a dual function. CND0 is used for counting both delays and occurrences. When counting delays, CND0 is constantly "true". The trigger filter is then switched off, and counting is continuous with the master clock CLM.

When CND0 is counting occurrences, the trigger filter is switched on. This utilizes the trigger filter to validate signal durations before they are accepted as signals.

If CND0 is constantly "true" for the set number of master clocks CLM, further triggering is blocked. CND0 must be first false and then true in order to restart the trigger filter. CND0 = "true" can only allow triggering once per occurrence.

4.1.4.3 Occurrence Counter

After the trigger filter processes the condition bits CND0 and CND1, CND0 goes through another processing in the occurrence counter.

The occurrence counter is a loadable 16-bit/100 MHz synchronous counter. The condition bit CND0 is only released for further processing when the occurrence counter has counted the set number of CND0 samples that can be preprocessed.

The occurrence counter can be used in two operating modes:

1. Delay counter mode
2. Occurrence counter mode

In the delay counter mode, the trigger filter is turned off and CND0 is constantly true. The occurrence counter thus counts the set number of CLM periods and then releases CND0 as the signal NXTLV, for incrementing the level counter (corresponds to incrementing the trigger level).

In occurrence counter mode, the trigger filter is turned on. The occurrence counter counts off the set number of events with the preprocessed condition bit CND0, and then releases the level counter for incrementing with the signal NXTLV. An occurrence is defined as the single appearance and disappearance of a trigger condition.

4.1.4.4 Level Counter

The level counter is a loadable 4-bit counter. Its outputs represent the level address of the trigger level. There are 16 physical trigger levels. Complex trigger instructions such as, "IF WORD1 OCCURS BETWEEN n AND m CLOCKS THEN... available to the user can reduce the available levels down to a minimum of 5, depending on the instructions.

The level address is set on the B BUS in the form of the signals

SLV0, SLV1, SLV2, SLV3

and made available to the DMSs. The DMSs can execute trigger word search independently of the trigger level. In addition, level RAMs on the SEQ can be controlled by level addresses.

The level counter can execute two operations:

1. Increment
2. Jump

Incrementing the level counter is released by the condition bit **CND0** which is preprocessed in the trigger filter, and the occurrence counter.

Jumping to any other level is executed by loading a destination address. The jump is released by the condition bit **CND1** preprocessed in the trigger filter. The destination address is stored in the level RAM, and can be set individually for each trigger level.

4.1.4.5 Level Change Control

When the level counter is changed by incrementing or jumping, the level change control checks and ensures that the trigger word search begins in a defined way in the new trigger level. To accomplish this the following tasks are executed:

1. Disable Condition Bits
2. Load Occurrence Counter
3. Reset Trigger Filter

a. **Disable Condition Bits**: The level change control produces a 30 ns wide pulse that blocks the condition bits **CND0** and **CND1** for the duration of the level change. The level counter is blocked from registering glitches, which could originate on the DMBs condition circuits during the level change of the condition RAM.

b. **Load Occurrence Counter**: The load signal **OCCLD**, and the clock pulse CLOCC are produced about 30 ns after the level change begins, and they load the occurrence counter with a preset value in the new trigger level. By this time, the new value of the occurrence counter from the level RAM is already stable.

c. Reset Trigger Filter: The trigger filter is reset during a level change, by disabling the condition bits and the additional clock pulse. Thus, a trigger word in the new trigger level can be recognized as quickly as 40 ns after the beginning (rising edge of the master clock CLM) of the level change.

4.1.4.6 Level RAM

The level RAM is controlled by the level address of the level counter. In the level RAM, all the parameters which can be set for the trigger word search are stored.which can be set for a trigger word search, depending on level (with the exception of trigger words in the conditional RAMs on the DMBs). The following parameters are contained on each trigger level:

4-bit destination with which the level counter is loaded during a jump

16-bit value for occurrence counter

4-bit value for trigger filter

FILOEN enables/disables trigger filter for CND1

FIL1EN enables/disables trigger filter for CND1

TRANSEN controls transition recording mode, see 2.4.2.2

GLITEN releases GLIT alternately to CND0, see 2.4.1

CLMS0, CLMS1 select master clock CLM, see 2.2 TBQ

TRG = final trigger. This signal indicates finding of last trigger condition in a trigger sequence. Trigger search is interrupted. Only the trigger delay counters run, and at the end of trigger delay, recording is blocked.

4.1.4.7 Record Controller

The record controller function block consists of the following modules:

1. Record Module
2. Trigger Delay Counter
3. Time Measurement Control

The record controller processes the condition bits produced by the DMBs:

CND2, CND3, TCLK

From these condition bits, the record controller generates the signal:

RECORD

in the record module. From this RECORD signal, the trigger delay counter module generates an individual recording signal for each DMB:

REC0, REC1, REC2, REC3

4.1.4.8 Record Module

With the record module, four different recording modes can be checked:

1. Normal Recording
2. Data Qualified Recording
3. Transition Recording
4. Level Selected Recording

Except transition recording, recording in the other three modes is controlled by the condition bits CND2, and CND3. CND2 and CND3 are equally weighted and are OR'ed in the record module. Therefore, a recording will be released if only one of the two condition bits is "true".

For transition recording mode, only TCLK is used to release recording. CND2 and CND3 are blocked by software.

Normal Recording: In this mode, one of the two condition bits CND2 or CND3 is constantly "true". Thus, the record signal RECORD is also constantly "true" and recording is continuous. This recording mode is possible at all clock rates in interlace and non-interlace mode.

Data Qualified Recording: In this mode, the condition bits CND2 or CND3 are only "true" when the data sampled on the DMBs agree with the preset trigger words. Thus, RECORD is "true" only when certain data are qualified by trigger words for CND2 or CND3. This recording mode is possible with an internal as well as an external clock up to a sample period of at least 40 ns (only in non-interlace mode).

Transition Recording: In this mode, recording proceeds only when the TCLK signal is produced by a data change in the transition detector on the DMB . This signal is processed in the record module. A digital filter ensures that the minimum distance between two recordings is 40 ns. If more data changes occur within this period, the digital filter waits until no more data changes occur for at least 40 ns. After this, RECORD is set up to capture the "interpolated" data. This recording mode is only possible in non-interlace mode, and with a sample rate of 20 nsec.

Level Selected Recording: This mode is software controlled, and is above the previous modes in rank, because it has control over the selection of the other types of recording. It allows "NO RECORDING IN THIS LEVEL" for all levels, in order to suppress the recording of irrelevant data. For data qualified recording, it also allows other data to qualify for recording, in every trigger level. Control for normal recording and data qualified recording proceeds by loading the appropriate condition RAMs on the DMBs. Transition recording is controlled by the TRANSEN signal from the level RAM.

4.1.4.9 Trigger Delay Counter

From the RECORD signal generated from the record module, the trigger delay counter module produces an individual recording signal for each of the four DMBs:

REC0, REC1, REC2, REC3

The trigger delay counter also determines the position of the trigger point in the recorded data. After the final trigger is recognized (TRG is "true", see 4.1.4.6), the trigger delay counter blocks the signals

REC0, REC1, REC2, REC3

after a preset number of samples has run. This preset number of samples is the trigger delay setting.

In the data qualified and transition recording mode, the trigger delay counter only counts if a RECORD signal produced by the record module is present.

If a counter has run out, a bit is set in a register. This register can be read out by a microprocessor.

In the trigger delay module, there is also a register that allows the logic analyzer to operate in mixed recording modes. This register can switch the RECn signal for each DMB individually into normal recording mode, although other DMBs are recording in data qualified recording mode, transition recording mode, or level selected recording mode.

4.1.4.10 Time Measurement Control

The KLA offers the time measurement board TMB as an option. To control this board, the time measurement control generates a clock and a control signal:

CLT, RECT

Time measurement control can operate in two modes:

1. Time Measurement
2. Clock Counting

Time Measurement: In this mode, the clock CLT is derived from the clock CL10 by the TBQ. It has a period length of 10 ns. The control signal RECT is a 10 ns wide pulse that is always produced when the internal record signal RECORD is "true" at the time of the rising edge of the master clock CLM. With these signals, the TMB can measure the times between two recordings, when in data qualified recording or in transition recording modes. For level selected recording, the interval between two recorded data blocks is measured when "NO RECORDING IN THIS LEVEL" is set. In normal recording with an external clock, the period length of this clock is measured when it is selected as the master clock. The measurement resolution amounts to 10 ns. The maximum interval that can be captured is 42.95 sec.

Clock Counting: In this mode, CLT = CLM. The control signal RECT corresponds to the internal record signal RECORD. With these signals, the TMB can count the number of master clocks CLM between two recordings, when in data qualified recording or in level selected recording.

4.1.4.11 Outputs

The SEQ has the following TTL level signals on BNC plugs for communication with the outside world:

1. Trigger
2. Trace

Trigger: The rising edge of this signal marks the time point of the final trigger; that is, the last trigger condition in a trigger sequence is satisfied.

Trace: This signal corresponds to the internal RECORD. A positive level indicates that data have been found. In normal recording mode, the entire recording period is marked this way. In data qualified mode, it signals that qualified trigger words have been found. In transition recording mode, it announces the appearance of a data transition.

Besides this, the SEQ has two terminals for self-test of:

1. Data Probes
2) Clock Probes

These terminals serve as data or clock sources for the probes. To execute the self-test, the **DATA PROBES** only need be connected to a **DMB** and the **CLOCK PROBES** to the **TBQ**. The self-test checks not only probes, but also the input portion of the connected board at the same time.

Data Probe Test Terminal: For DATA PROBES, the outputs of an 8-bit BCD counter (data pattern 00 to 99) are produced at ECL levels. The counter is incremented every 100 ns with the **CL100** clock supplied by the **TBQ**.

Clock Probe Test Terminal: For the CLOCK PROBES, the **CL100** clock is output at ECL levels on bits 0 and 1 of the terminal. The **CL100** clock has a period length of 100 ns (40 ns = high, 60 ns = low). The same pattern appears on bits 2...7 of the terminal as on bit 0...5 of the data probe test terminal.

4.1.5 TIME MEASUREMENT BOARD TMB

The time measurement board **TMB** is found in the lowest connector on the **MOTHERBOARD**.

The **TMB** measures time intervals, for counting clock intervals between the last recording and the one currently taking place in data qualified recording, transition recording and level selected recording. The **TMB** contains two function blocks for this:

1. Time Counter
2. Time Memory

Control of the **TMB** is via the clock **CLT** and the signal **RECT**, which is produced on the **SEQ** in time measurement control.

4.1.5.1 Time Counter

The time counter consists of a 32-bit synchronous counter with a counting frequency of 100 MHz maximum. The clock for this counter is **CLT**.

For clock counting, **CLT = CLM**.

For time measurement, the clock period of **CLT** = 10 ns

For this clock period of 10 ns, the largest measurable interval between two recordings is 42.95 sec. If this is exceeded, the counter begins again at zero.

The most significant 4-bits of the counter are displayed. The toggle rate of the most significant bits is 20.475 sec (for clock rate of 10 ns).

The clock is reset when the signal RECT is true.

4.1.5.2 Time Memory

The time memory is 32-bit x 2K, with a cycle time of 40 ns. The time counter status is stored in time memory when the signal RECT is true.

If RECT is true more often than every 40 ns during a time measurement, another recording of the counter status will not take place, since the last memory cycle is not concluded yet. In this case RECT is ignored.

4.2 DATA PROBES (BOARD 410)

The logic analyzer's gets all its inputs through the data probes. All data probes have a high input resistance, a low input capacitance, and a current threshold which can be set individually for each probe.

Probes are connected by two-meter long, flexible round cables and a 37-pin D plug. The plug housing is equipped with spring clips so that it can be secured to the rear panel connector.

Data is conveyed to the probe through a 16-pin connector with 9 cables in resistor color code (8-bit data and 1 ground) mounted to it. The cables end in wire-wrap plugs that can be inserted directly into wire-wrap pins, or to IC test clips.

The data probe has 8 channels. It is a universal probe and can be used as a data probe or a clock probe. When used as a data probe, 8-bit data are gathered. When used as a clock probe, bits 0 and 1 are input as clock, and 2...7 are clock qualifiers.

The probe's input amplifiers are manufactured in hybrid technology and have an input resistance of 1 MegOhm, an input capacitance of $\leq$ 5 pF, and a bandwidth of 350 MHz. The input amplifier functions as an impedance transformer and forms the difference between the input signal and the threshold.

The threshold is produced directly in each probe by an 8-bit D/A converter. This 8-bit word is transmitted serially by the signals DP (data) and CLP (clock). The threshold can be set in increments of 100 mV from +12.6V to -12.6V.

The output signal of the input amplifier is checked in an ECL comparator, and transmitted on a round cable with a controlled impedance.

4.3 DISASSEMBLER HARDWARE

The general philosophy of disassembly is to sample the microprocessor with a high impedance using a variable threshold. This means that individual processor pins must be directly connected to the probes. The flexible structure of the logic analyzer hardware allows the necessary demultiplexing and selective recording for most microprocessors, without additional hardware. Only a rewiring of processor pins is necessary. Connection of the **DATA PROBES** is through the following disassembler hardware components:

1. Universal Probe Rack
2. Configuration Modules
3. Test Adapters

A nearly perfect disassembly is possible when combined with processor-specific software.

4.4 UNIVERSAL PROBE RACK

The universal probe rack **UPR** is a screw-in rack for probes. These are plugged into a motherboard in the **UPR**, which connects the individual probe channels on two 64-pin, edge connectors.

UPR-6 for 6 probes
UPR-10 for 10 probes

UPR-10: The connector accepts 8 data probes and 2 clock probes, which is sufficient to connect 64-pin processors. The motherboard for the UPR-10 is board 385.

4.5 REGISTER ASSIGNMENT

The entire logic analyzer hardware is set via registers. The address of these registers is constructed of board address (for the **DMBs** plug-specific), and the register read/write address. The address given in the register assignment is complete.

The various memories on the boards are also treated like registers. They behave like registers of a definable depth. The address pointers of the memories are set either with reset or load.

The registers are differentiated thus:

read only register RO
write only register WO
read/write register RW

The register address for read only register and write only register is handled independently, that is, the same address for RO and WO refer to completely different registers. For RW the same read and write address is used.

There are differences in the time access of the microprocessor to the register:

access anytime
access (only when the KLA is) diaarmed

The logical polarity of the control bits indicated in the register assignment corresponds to the logical polarity of the bits output or received by the microprocessor.

CHAPTER 5

GLOSSARY

This chapter defines and explains concepts generally applicable to logic analyzers, as well as some terms specific to the KLA. Additional meanings associated with these terms in other areas of electronics are not discussed here.

ARM

This concept as used with logic analyzers means to enable or to start a data recording which is subsequently stopped (disarmed) after certain trigger conditions have occurred.

It also applies to the start of data recording or trigger search in channel B, after certain trigger events have occurred on channel A, where the two channel groups are recorded with separate clocks.

See also **MASTER CLOCK, SIMULTANEOUS TIME/DATA ANALYSIS, SIMULTANEOUS DATA ANALYSIS WITH VARIOUS CLOCKS**

ARRANGEMENT

Arrangement is the combination of two or more 16-channel memory blocks of the KLA so that they are recorded together, with one clock or with several ORed clocks. If memory blocks are not combined in Arrangement, then the recording of the 16-channel blocks proceeds independently.

ASYNCHRONOUS DATA RECORDING

Asynchronous data recording is a sampling of input signals using a clock asynchronous to these signals, usually the internal clock of the logic analyzer. Asynchronous data recording is most often used for time analysis. Signals are sampled at regular intervals, and the number of consecutive memory places containing the same signal condition shows the duration of this condition. Since the maximum attainable resolution is the time of one sample, the clock should be set as high as necessary to meet the speed and accuracy requirements of the data. At all times, the clock rate should be set faster than the data being analyzed.

See also **TRANSITION RECORDING**

CLOCK

Modern logic analyzers allow simultaneous recording with several different clocks; both internal asynchronous, and external synchronous recording is possible. KLA 64 permits simultanous recording with up to four clocks. External clock sampling can proceed either on the falling or the on the rising edge of the clock. Selection of both edges is possible with the KLA.

Logic analyzers differentiate between internal clock recording and external clock recording. With the internal asynchronous clock, every system state must be captured several times in succession, whereas the external (synchronous) clock samples only once. Therefore the required clock frequency for the internal clock is faster by a multiple of the external clock.

See also **MASTER CLOCK**

CLOCK CONNECTION

See **OR CONNECTION OF CLOCKS**

CLOCK ENABLE

The recording clock can be enabled or disabled by means of clock qualification.

CLOCK QUALIFICATION

Clock qualification permits enabling or disabling clocks for recording data. A sample is taken only when a predefined state is present at the time of the selected active clock edge. This allows very selective data collection. Only trigger words qualified by state and clock edge will trigger.

CLOCK RATE

This refers to the clock frequency being used. It is often used to mean the "clock period", which is the time interval between two rising clock edges.

COMBINATION TRIGGER

The combination trigger searches for a preset word. The trigger condition is considered fulfilled when such a word is captured during sampling. Combination trigger can also be used in sequential triggering where a series of several data words are searched.

COMPARE

Compare means a data comparison between source data and reference data. This comparison is executed by selecting cyclic record/compare from the COMPARE menu. Any segment in the source and reference memory, and channels or groups of channels can be compared. This comparison can be executed with jitter (edge shift tolerance). When the searched for condition appears, (for example, an error) the process can be interrupted and the recording frozen, or a cycle counter can be incremented, or the entire new recording can be stored on a floppy diskette.

COUNTS

This refers to the number of clock cycles, which the user can define as counts, between appearances of trigger words and subsequent trigger events.

```
Example:    <1> IF WRD1 OCCURS 00001 TIMES ANYTIME, THEN GOTO<2>
            <2> IF WRD2 OCCURS BETWEEN 00100 AND 00120 COUNTS,
          THEN RESTART
          ELSE TRIGGER
```

In this example, triggering occurs exactly when Word 2 does not appear between the 100th and the 120th count after Word 1. This corresponds to a time interval of 1 to 1.2 microseconds when the internal clock is at 100 MHz.

CURSOR

The KLA has two types of cursors:

1. Cursor lines in time display or the corresponding positions in the data list.
2. Blinking field or parameter cursor which must be positioned on the parameter field when parameters in that field have to be modified or input.

Cursors can be moved horizontally in the timing display, and vertically in the data list by using the four movement keys, or they can be continuosly shifted by giving a jump address.

DATA COMPARISON

See COMPARE

DATA DISPLAY

Data captured in the data domain can be displayed on the screen in the data display or data list. The location in memory of data can be listed in any one of the six available formats: binary, octal, hexadecimal, decimal, ASCII, and EBCDIC. The external (system) clock, which samples a given system state only once, should be used for data display, since this type of display contains no time information. The data list then shows a different state in each line, which makes the display easy to read.

Option TM of the KLA allows time information to be displayed in the data list next to each piece of state information. With option TM, either the duration of the system state, or the time interval to the trigger point can be calculated.

DATA DOMAIN

Analysis In The Data Domain

Logic analyzer recordings can be made in time domain and in data domain. Data domain recordings display information about states and not time. For data domain analysis, a synchronous target system clock is used as the recording clock. If the target system clock is structured so that every data word is sampled only once, the screen will display a state analysis in the form of a data list. Each line shows exactly one state of the system being tested. The display can be in one of the six data formats available: binary, octal, hexadecimal, decimal ASCII, and EBCDIC. With a synchronous clock, the time length of each individual sample (relative to the sample time), is recorded. If the target system must be asynchronous, a state recording with relative state durations is only possible with Transitional Clocking, or with the KLA Transitional Recording.

DATA HOLD TIME

Data hold denotes the length of time that data must remain stable after the active edge of the clock in order to be sampled. Data hold time is significant when the external, synchronous target system clock is being used.

In microprocessor analysis, data hold time is more critical than data setup time, and should be as small as possible. KLA data hold time is typically 2 nanoseconds.

DATA LIST

See **DATA DISPLAY**

DATA QUALIFIED RECORDING

This is a process where predefined data words can select the type of data which gets recorded. The existing data is sampled with every active clock edge. Either the rising or the falling edge can be selected as active. It is compared to a preset bit pattern (qualifier words consist of "1", "0", and "X" = don't care). Data is stored in memory only if it agrees with these predefined data words.

Data qualified recording allows narrowly defined types of data to be recorded, for example, accesses to a certain I/O port or only the data from a limited address range can be selected for recording.

Data qualified recording when combined with Level Selected Recording allows different qualifier words to be defined in every trigger level.

Data qualified recording in connection with Option TM determines the time intervals between recorded data as absolute times with resolution of 10 nanoseconds, or it can define the times between samples in units of the recording clock. In both cases the time intervals are stored. Thus a narrowly defined data, such as the time of access to a specific I/O port can be determined very closely.

See also **CLOCK QUALIFIER**

DATA SETUP TIME

This is the minimum length of time that the data must be present before an active clock edge in order to be captured. This time is very important in hardware circuit analysis, and should be as small as possible. KLA setup time is typically 2 nanoseconds.

Data setup time is significant only with synchronous recording, using the external clock of the target system.

DEFAULT, DEFAULT SETUP

Default signifies the basic setup of the KLA when initially turned on, as well as the basic setup of individual parameters or parameter groups. Both the entire basic setup and portions of it are modifiable. The entire basic setup is represented by a modifiable DEFAULT file, which is one of 10 such files stored on a floppy disk. The disk contains a complete parameter setup file, and a complete set of reference data which can contain data from a previous recording.

DELAY, TRIGGER DELAY

Trigger delay means the number of samples read in after triggering has occurred.

If n= trigger delay
m= memory depth

then,

When m is greater than n, number of data words equal to n will be recorded after triggering.

When n is greater than m, the trigger point will no longer be in memory. In this case, a time window which is dependent on certain trigger conditions, and which begins a certain time after triggering, will record post trigger events.

When recording simultaneously with different clocks, the trigger delays of the clocks will correspond to each other with respect to the clock cycles involved. However, since the clock times are different, they will not correspond to one another in absolute time. Therefore, the recording will end at different times in different memeory blocks.

With simultaneous recording, a memory location will exist where all the data will appear at the same time, or at least within one clock period of the master clock.

See also **PRETRIGGER, MIDTRIGGER, POSTRIGGER**

DISASSEMBLER, DISASSEMBLED DATA DISPLAY

Disassembler is a function which allows the user to display a trace recording as mnemonics. Disassembling requires that data be collected according to microprocessor dependent criteria during recording. Depending on the microprocessor, several signals must be connected to each other as recording clocks, or clocks may have to be qualified. Also the command processing of the microprocessor must not be interrupted.

Because the disassembler function cannot distinguish between executed and not executed commands, 16-bit processors which have an opcode prefetch may require additional hardware modifications to permit actual display of the complete program.

A given microprocessor may require special software to display important additional information, such as what specific data was transferred during command processing, or whether an I/O port was accessed. Also data which does not belong in the running of the program, such as refresh cycles, must not be displayed.

DON'T CARE

This concept applies to trigger words and also to the clock trigger, and data qualification.

1. Trigger Words: These are "1", "0", and "X" which equals don't care. During trigger word search, bits or characters set at "X" are not significant.

2. Clock Trigger and Data Qualification: The state of a bit or character set at "X" = don't care are not important in qualification.

EVENT

This term usually means trigger event, which can be the appearance of a trigger word or several trigger words that appear at specified intervals.

See also EVENT COUNTER

EVENT COUNTER

The event counter specifies the number of times a trigger word must be found to satisfy a trigger condition. The trigger word is counted as occurring again, only when at least one sample which does not contain the trigger word occurs between two sample points. This requirement is useful when dealing with a trigger word which appears once, but continues over several clock periods. Then it is counted accurately, and only once, regardless of how many times it is sampled in successive clock cycles. The trigger filter controls this requirement of having one sample where the trigger word is not found between two detections. If the trigger filter is turned off, every occurrence of the trigger word is counted.

Example:

```
IF WRD1 OCCURS 00100 TIMES ANYTIME, THEN TRIGGER
NO SECOND TRIGGERWRD
```

The event is the appearance of triggerword 1.
The delay number = 100.

GLITCH

Glitch is used to refer to two or more data transitions between two active clock edges. Often, but not always it is only a few nanoseconds in duration, and is not captured by sampling. However, it can influence the operation of logic and disturb the functioning of the system which is being tested.

During sampling with an asynchronous internal clock of high frequency, no more than one transition of data can lie between two active clock edges. If during one clock cycle two or more data transitions appear on one channel, this indicates a glitch. Every logic analyzer distinguishes between regular data and glitches with this criterion:

> If two or more signal transitions appear on one channel between two sample points, it is a glitch.

GLITCH CAPTURE

Logic analyzers use two processes to capture glitches.

1. Latch Mode. In latch mode glitches are captured and stored in the same memory as regular data. In this mode only glitches that have a time interval to the next data transition of at least two clock intervals can be latched.

2. Glitch Storage in Separate Memory. This is the method used by the KLA, and it always differentiates between glitches and regular data. Thus glitch display is unambiguous and easily identifiable. The advantages of this type of glitch capture are fourfold:
   a. Glitches are not mixed with data in memory.
   b. Glitch capture is certain even when glitches occur immediately before or after signal transitions.
   c. KLA can trigger on glitches on any trigger level.
   d. KLA's memory can be searched for glitch information.

GOTO

The command GOTO followed by a trigger level name such as A, sets a jump to trigger level A. This command along with RESTART and TRIGGER is used in finding a word within a limited time window.

HOLD TIME

See DATA HOLD TIME, QUALIFIER HOLD TIME

HOME ADDRESSES

These are user selectable addresses for the first memory location of data, or for a time display, or for the cursor. When the jump is executed, an exchange of the origin and destination addresses occurs, so that when the HOME key is pressed repeatedly, the data display or the time display will jump back and forth between these addresses.

INPUT IMPEDANCE

The KLA has an input impedance of 1 Megohm $\leq$ 5 picofarads. This provides high resistance, low capacitance pods, for use in high frequency microprocessor circuit analysis.

INSTRUCTION PREFETCH

See OPCODE PREFETCH

INTERLACE

The memory circuits used in a logic analyzer can read in data up to a maximum clock rate of 25MHz. The interlace mode allows the logic analyzer to overcome the 25 MHz limit of the memory chips and operate at higher frequencies. In interlace mode, memory blocks are combined so that data is read into first one, then the other memory block. When two memory blocks are thus combined, the frequency of the recording clock can be twice 25MHz. KLA uses this process to make each pair of memory blocks run in interlace internally, to provide a maximum clock rate of 50 MHz (25MHz x 2) at all times. When run in actual interlace mode the internal memory blocks are combined again into interlace to provide a maximum clock rate of 100 MHz (25MHz x 4).

JITTER, IGNORE JITTER OF...SAMPLES

Jitter is an edge shift tolerance which occurs while comparing source data and reference data. This tolerance (jitter) level can be set from $\pm$ 1 to $\pm$ 9. Comparison of two recordings executed in asynchronous sampling is meaningful only when a jitter of $\pm$ 1 per sample is set, otherwise the sample error unavoidable with asynchronous recording becomes a genuine error. Errors in comparison of asynchronous signal recordings can be elegantly avoided by the KLA, by setting time windows in the triggering.

If the data that are being compared are equal to a jitter of $\pm$ n samples, they are considered identical if "IGNORE JITTER OF $\pm$ n SAMPLES" has been set.

LATCH MODE

This is one of the two methods of capturing glitches.

See also GLITCH CAPTURE

LEVEL

See TRIGGER LEVEL, THRESHOLD LEVEL

LEVEL SELECTED RECORDING

Level selected recording mode of operation permits the selection of data to be recorded or not recorded at each trigger level (system state). For example, with Data Qualified Recording, the data to be recorded can be specified differently for each trigger level; all data, or certain specific data, or no data can be selected for recording. Since in each trigger level transitions in the program state can be detected, the data to be recorded can be individually selected for each trigger level.

See also **DATA QUALIFIED RECORDING, TRANSITION RECORDING**

LIST

See **DATA DISPLAY**

LOGIC STATE ANALYZER

This is a logic analyzer in data domain analysis.

See also **DATA DOMAIN**

MAGNIFICATION

This refers to the magnification factor in the time display.

See also **RESOLUTION**

MASTER CLOCK

Master clock is the clock which is used to search for individual trigger words. Logic analyzers that can record simultaneously with different clocks must refer to one of these clocks as the master clock, and all other clocks must be synchronous to the master clock. Problems occur with simultaneous recording in a multiprocessor system, where two CPUs with asynchronous clocks are recorded.

The KLA overcomes this problem by allowing the designation of a different master clock for each trigger level during simultaneous recording with several clocks. Thus, it is possible to trigger on different channel groups in different trigger levels, even when they have been recorded asynchronously to one another.

MNEMONICS

These are abbreviated designations assigned to the individual commands of a particular microprocessor by the manufacturer, or abbreviations assigned by the user to the individual lines of a time display in a logic analyzer. KLA allows the designation of mnemonics to two additional areas.

1. Mnemonics can be assigned to trigger words. Names of software routines, or labels of certain program locations can be given to trigger words.

2. Mnemonics can be assigned to system files stored on a diskette. Up to ten complete device setups, and ten reference data sets can be stored on a diskette. A mnemonic can be assigned to each of these files.

MULTICLOCKING, MULTIPHASED CLOCKING

This refers to simultaneous data recording with different clocks.

See SIMULTANEOUS DATA ANALYSIS WITH VARIOUS CLOCKS

NORMAL RECORDING

Normal recording as it applies to the KLA means that all data is recorded, and with every active clock edge a data word is read into memory.
KLA has three other types of recording: Data Qualified Recording, Transition Recording, and No Recording are the other options.

OCCURRENCE

See EVENT, EVENT COUNTER

OPCODE PREFETCH

Sixteen bit microprocessors such as the 8086/8088 and 68000 have a prefetch mechanism which causes new commands to be fetched into a queue, while other commands previously fetched are executing. If the bytes in the prefetch queue are not executed due to certain operating conditions, then they can be lost or erased. In analyzing programs for microprocessors with an opcode prefetch, special sophisticated software, and microprocessor specific hardware modifications may be necessary, if only those commands which were actually executed are to be detected and analyzed.

OPTION TM

Clock independent time measurement, an optional feature available with the KLA.

ORing, OR CONNECTION

As used with the KLA this term can apply to OR combinations of trigger words and also to OR combinations of microprocessor signals.

1. ORed Trigger Words. The KLA can search for two different trigger words at the same trigger level. When either word 1 or word 2 are found, the same instruction or two different instructions can be made to execute.

2. ORed Signals. For microprocessor circuit analysis often several signals are OR connected. A data word is always recorded when either one of the connected signals appears at a specified clock edge.

PARAMETER CURSOR

See CURSOR

PARAMETER FIELD

This signifies the reverse video fields on the CRT which contain the currently active, or the default settings for a parameter. To change parameters, the cursor must be positioned in the parameter field. Next, the desired setting may be selected from menus, or for numeric parameters, can be keyed in.

PERSONALITY ADAPTER

Personality adapters are probes designed for specific microprocessors, and usually contain a clock and a data conditioner for the logic analyzer. Such adapters eliminate the need for special hardware in many cases. For example, all supported 8-bit microprocessors use a universal adapter for connecting to the KLA.
The adapter is essentially a socket for the standard KLA pods and is adapted to different microprocessors by using a setup diskette to change configuration.

Clock qualification, clock rate, and microprocessor specific connections are provided by the initial system setup diskette which configures the KLA for a specific supported microprocessor. The microprocessor being tested is connected to a high impedance device, i.e. the probe, and unmodified signals from the CPU can be analyzed.

POD

This is a data collecting device which is external to the logic analyzer, and has 8 signal input connections. It contains a high impedance input amplifier, which conducts the input signals, usually as just high and low, to the logic analyzer.

POSTTRIGGER

This is one of two trigger settings in a logic analyzer, (pretrigger is the other one). The trigger delay setting is chosen so that the quantity of data gathered after triggering is almost as large as (usually 7/8th) the available memory depth. Thus, most of the recording will show events that are post trigger.

See also **DELAY**

PRETRIGGER

This is one of the two trigger settings in a logic analyzer, (the other one is the posttrigger). In this case the trigger delay is chosen so that the largest portion of data recorded in memory represents data which has been collected before the triggering.

PROBE

See **POD**

QUALIFIER, TRIGGER

Earlier logic analyzers which do not have sequential triggering, and allow only one trigger word, use additional qualifications to obtain unambiguous trigger conditions. A trigger word will be detected only when the signal matches a predefined signal state.

See also **DATA QUALIFIED RECORDING**

QUALIFIER HOLD TIME

This concept is analogous to data hold time. A given state must be present for at least the duration of the specified qualifier hold time before the next active clock edge, in order to enable that clock edge.

QUALIFIER SETUP TIME

This concept is analogous to data setup time. The qualifying signal state must remain stable after the qualified clock edge for at least the duration of the specified qualifier setup time.

RASTER

A raster is a gridwork of lines in the CRT time display and fulfills the following functions:

1. for visual orientation
2. to measure distances
3. in magnified time display to mark individual memory locations
4. to mark screen display intervals, that is, the minimum distance between two separately displayable clock edges

See also **RESOLUTION**

RECORDING

Recording refers to the data sampling and storage feature of logic analyzers. A recording begins when the logic analyzer is booted up and connected to a target system, and the RUN/STOP key is pressed. From this point on, all data is read into the recording memory at the rate of one data word per clock period of the recording clock. The newest data words are always found in memory. The recording stops after the trigger events are found, and the preset trigger delay counter time has elapsed. In the time between sampling and final storing, data is saved temporarily. The user can decide later whether to save the collected data word on diskette or not.

REFERENCE MEMORY

Most logic analyzers have two different blocks of memory, a source memory (recording memory) for recording data with a high speed clock, and a reference memory of equal size. The reference memory is used to compare the latest recorded data with earlier versions in recording memory. In the simplest case, this is a visual comparison on the CRT in the timing diagram and/or data list, where the differences are shown in reverse video. Using the reference memory, automatic data comparison search, or cyclic recording with comparison can be executed. The recording can be set to terminate when an error appears.

See also **COMPARE, TIME DISPLAY**

REMOTE CONTROL

KLA can be integrated into an automatic test system through RS-232C and IEEE-488 interfaces. In both cases, all KLA operations can be remotely controlled, including diskette read/write functions. All interface parameters can be set by an I/O menu.

RESOLUTION

Resolution refers to two different concepts with the KLA. First, it refers to the clock frequency during time analysis with asynchronous clocks. The higher the clock frequency, the greater the resolution achieved. With most microprocessor systems a clock rate of 100 MHz is adequate, since the shortest time to execute a command with most microprocessors is about 1 microsecond. This means that the command would be captured by 100 samples.

The second concept refers to the resolution of the display for the stored data, which is dependent on the magnification factor chosen. KLA will shade the display area if two edges cannot be displayed separately, because the selected magnification is too low. When the greatest magnification level is chosen, KLA displays consecutive transitions separately, without display errors.

RESTART

This is a jump command to the first trigger level. This instruction can be set anywhere in the trigger sequence, and will cause the appearance of a searched word from the first trigger level.

See also SEQUENTIAL TRIGGERING

SAMPLING

Samples are captured and recorded in relationship to the active edges of the sampling clock. The sampling clock can be external synchronous only. Either the rising or the falling edge can be defined as the active edge. At the selected edges of the clock, data is sampled from the input comparators and is detected to be HIGH of LOW in reference to the threshold voltage set at the input comparator.

Captured data is temporarily stored, afterwards only the data that agrees with certain conditions is stored in memory.

SAMPLE ERROR

When an asynchronous clock is used to sample and record input signals, the transitions captured will have and uncertainty of $\pm$ 1 count. When two recordings are made subsequent to one another, data transitions that correspond to one another may appear shifted in memory by $\pm$ 1 memory location.

See also **JITTER, ASYNCHRONOUS DATA RECORDING**

SEGMENT

Segment is a section of either source, or reference memory, where a starting address and an ending address have been defined for data comparison purposes. Such segments are defined independently for source and for reference memory, but must be of equal length in order to be compared. After each recording, these segments may be compared with one another on any channel groups.

See also **COMPARE, JITTER**

SEARCH

Automatic search capabilities of the KLA are the following:

1. Comparison searches between source and reference data
2. Word search
3. Complete word series search (input trigger word or mnemonic)
4. Callup and search data word (input a memory address with that data word)

SEARCH AREA

This is an area defined by the user, in which a trigger word can be searched.

EXAMPLE: IF WRD 1 OCCURS BETWEEN 6 AND 11 COUNTS, THEN TRIGGER
ELSE RESTART

In this example triggering occurs when WRD 1 appears between the 6th and the 11th count after the previous trigger word. If not found, RESTART is executed.

It is also possible to search for the absence of a trigger word in a search area.

EXAMPLE: IF WRD 1 OCCURS BETWEEN 6 AND 11 COUNTS, THEN RESTART
ELSE TRIGGER

In this example, when WRD 1 is found, system is restarted. Triggering occurs when WRD 1 is NOT found.

SELECTIVE TRACE

Selective trace is the recording of data that must agree with one or more qualifier words at all locations except where "X"=don't care is the qualifier word. Such selective qualifier conditions are set by:

TRACE ONLY... or
TRACE IF DATA...

Normally, such qualifier conditions will cause the loss of all clock edge references. If time references are required, first the data is read in with each active clock edge, then the selective recording with qualification is executed. Only the data which meets the qualifications is stored in the final recording.

See also DATA QUALIFIED RECORDING, TRANSITION RECORDING

SEQUENTIAL TRIGGERING

Sequential triggering means specifying several trigger words in a certain sequence, such that each word must be detected in sequence before the next trigger word is searched, and each one must be detected in the proper sequence to cause triggering. It is used to make triggering conditions unambigous. Additional parameters may be specified to reduce the number of trigger words needed in the sequence. For example, the event counter may be used to specify the number of times WRD 1 must be counted before WRD 2 is searched. Search areas, or clock periods can be used to reduce ambiguity.

When OR combined trigger words are used in sequential triggering, two or more data events are searched simultaneously, and when any one is detected triggering occurs. For example, an application of ORed trigger words is where WRD2 should not appear in a given program segment. If it appears anyway, this error situation should be triggered and analyzed later.

See also SEARCH AREA, THEN NOT TRIGGERING, OR CONNECTION

SETUP

Up to ten complete device setups can be stored on diskette for the KLA. A complete setup contains all the settings selected from the various menus, and parameters such as clock frequency, memory configurations, thresholds, trigger conditions, trigger words, order of time display and data display. Each setup is stored under a user selected mnemonic on the diskette.

SETUP TIME

See DATA SETUP TIME

SIMULTANEOUS TIME/DATA ANALYSIS

Simultaneous time/data analysis is used to analyze functional problems in the system which may be due to the interaction of hardware and software. A critical signal can be analyzed at a specific location in a program, and the cause of the problem can be isolated. Since this type of analysis is in both data domain and time domain, two independent clocks are used; the internal asynchronous clock of the logic analyzer for time analysis, and the external clock for the data analysis. The resulting data lists have no time reference; in fact, the trigger word is the only time correlation point between identical memory addresses found in both data channels, and in time channels. This makes it important to trigger as accurately as possible on the critical data point, so that a timing reference point for the data list in the data domain is obtained.

KLA allows the switching of the master clock from the data domain to the time domain, thus providing alternate triggering between the two channel groups.

See also **MASTER CLOCK, ANALYSIS IN THE TIME DOMAIN, ANALYSIS IN THE DATA DOMAIN**

SIMULTANEOUS DATA ANALYSIS WITH VARIOUS CLOCKS

In a multiprocessor test environment, there is an interaction between the microprocessors being tested. It is necessary to record each microprocessor with its own clock. If the two CPUs have asynchronous clocks, this problem will have to handled similar to SIMULTANEOUS TIME/DATA ANALYSIS discussed in the immediately preceding glossary entry. That is, each recording clock is alternately assigned to be the master clock, and triggering occurs alternately on different systems. This data will simulate the interaction between the two processors.

SKEW

Skew is the time difference caused by the internal delay in sampling or storing two simultaneous inputs appearing on two different data channels. The skew time must be smaller than the shortest sample interval. If the skew time is close to equaling the sample time, simultaneously appearing data changes may be latched. The channel to channel skew for KLA is only 2 nanoseconds.

Skew is also used in connection with setting an allowable edge shift (jitter) between source and reference data in cyclic recording/comparison process, (also called babysitting in the manual).

SOURCE, SOURCE DATA, SOURCE MEMORY

This means the data stored in the high speed acquisition, or source memory, as opposed to the data found in reference memory.

START MAGNIFICATION

This refers to the first memory address of a magnified time display. In the display of the entire memory, this location is marked with "S" set. The starting point of magnification can be scrolled or jumped to by setting the starting point as the HOME address.

STATE ANALYSIS

See **ANALYSIS IN THE DATA DOMAIN**

SYNCHRONOUS RECORDING

Synchronous data recording means sampling input signals with a clock synchronous to the same input signals. The recording produces a state analysis, and is read in the data domain display where each data line represents one memory address.

When using a synchronous (external) clock, in order to get a resolution equal to that obtained with an asynchronous (internal) clock, the synchronous clock rate must be set smaller than the asynchronous clock rate by a factor of the internal clock cycle. In all cases, the external clock cycle must be faster than the data, to allow data to be sampled at the rate of one data line per clock cycle.

Other important considerations during synchronous recording are memory depth, data setup and data hold times. Channel to channel skew is less significant.

THEN..., THEN NOT...

These conditions are used in sequential triggering. If the search for a trigger word is introduced by THEN..., triggering or any other specified condition occurs each time the word is found. For example,

```
IF WRD 1 OCCURS 000100 COUNTS THEN...TRIGGER or
                                     GOTO WRD2 or
                                     any other instruction set
```

If THEN NOT... is set, each time the word is NOT found, the trigger condition is considered fulfilled, or other instruction sets are executed. For example,

IF WRD 1 OCCURS, THEN NOT...TRIGGER etc.

THEN NOT... searches must be limited to specific time period set by the user. When the trigger condition is fulfilled, it will automatically jump back to the first trigger level, unless another address has been specified by the user.

See also **SEARCH AREAS, SEQUENTIAL TRIGGERING, OR CONNECTION**

THRESHOLD

Threshold is the voltage conducted to an input comparator by an input signal, and is recognized as HIGH or LOW, depeding on whether it is above or below the set threshold level.

Logic analyzers offer both fixed (TTL, ECL) and programmable threshold levels. KLA offers four programmable thresholds ranging from 0 to $\pm$ 12.7 volts, which can be assigned to different channel groups.

TIMING

See **TIME DISPLAY**

TRACE CONTROL

When using the KLA in the LEVEL SELECTED RECORDING mode, different conditions can be set at each trigger level for the control of the trace.

See also **LEVEL SELECTED RECORDING**

TRANSITIONAL SAMPLING, TRANSITIONAL CLOCKING

Transitional clocking is a recording process which uses the individual signal transitions as the sampling clock. A new data word is captured and stored when a data change is present on at least one of the connected signals. Because all time information is lost, this type of analysis is best for doing state analysis when using asynchronous clocks. Storage of data is limited only by the amount of memory locations available.

See also **TRANSITION RECORDING**

TRANSITION RECORDING

Transition recording is one of the two selective recording processes available on the KLA. (The other process is DATA QUALIFIED RECORDING). All recordings are made with a fixed clock of 50 MHz, and only those words that have undergone a transition since the last recording of the same data word are transferred to memory. The advantage is that search areas can be defined in units of the 50 MHz clock. If the KLA has the TM option, then time reference can be obtained with Transition Recording. Time distances between signals can be defined with a resolution of 10 nanoseconds, and can be 43 seconds apart at the maximum. Since search areas can be defined in units of the 50 MHz clock, and with the TM option, time periods between events are known, a timing diagram can be constructed.

TRIGGERING

Logic analyzers trigger on states or words and not clock edges. A trigger event usually ends a recording after a user defined trigger delay interval.

TRIGGER CLOCK

See MASTER CLOCK

TRIGGER DELAY

See DELAY

TRIGGER LEVEL

A trigger level is one level in a multilevel trigger sequence, during which one or several data words can be searched and detected simultaneously. (KLA allows up to two different words per level). Simultaneous multiple word search is the basis for the concept of trigger levels. Trigger levels can be combined with additional conditions such as limited time, search area, event counter to increase the versatility of the search.

TRIGGER FILTER

Trigger filter is a programmable value which indicates the number of counts a data word must remain stable in order to be detected as found. Two or more counts should be set as the minimum trigger filter value.

This feature is very useful in asynchronous sampling and recording, where the asynchronous clock active edge can coincide with a state change in the target system. But since the state change is of a short duration, and the next asynchronous active edge may fall at a different time, the state change will be missed, even if it fulfills a trigger word requirement.

TRIGGER LOCATION

The location of the trigger in memory depends on the duration of the trigger delay that was set, and the amount of available memory. If the trigger delay is set as n counts, then the trigger event will be located n counts before the end of the recording.

See also **TRIGGER DELAY**

TRIGGER MONITOR

KLA has a trigger monitor which allows the user to follow his progress through the various triggerlevels, and gives information on the following:

1. The trigger level which is active at the moment
2. The status of the event counter, which shows how often the trigger word has been found

The trigger monitor is especially useful in detecting a trigger event which has not occurred, because a searched word was not found in a given trigger level. While the KLA is searching for trigger conditions, new data is continually being recorded into source memory at clock speeds of up to 100 MHz. The memory always contains the latest 2048 data words, but these can only be displayed when data the recording is interrupted because a trigger event has been found. Manual interrupt of the recording is possible, but should only be done after the critical trigger event has occurred.

TIME ANALYSIS

The duration of a sample can be determined by two methods; asynchronous sampling, and measurement of time intervals between sample points.

1. Asynchronous Sampling. The duration of a sample can be calculated from the number of successive memory locations where the sample occurs. For example, if a state is found in n successive memory locations then the duration of the state is equal to:

   $$(n \pm 1) \times \text{sample interval}$$

2. The duration of a sample can be determined by measuring time distances between sample time points, when recording with an external synchronous clock, or during transition recording or data qualified recording. The time distances can be determined with 10-nanosecond resolution, and stored. The maximum time distance between two data words stored is approximately 43 nanoseconds. Later, a timing diagram can be reconstructed from the stored data.

TIME DISPLAY

Logic analyzers display the time analysis data in a timing diagram. KLA can display up to 16 channels and/or input signals as lines on the screen. A mnemonic can be assigned to each channel. Both source and reference data can be displayed.

A timing diagram can be called up during transition recording. However, during data qualified recording, time distances between sample time points is displayed as a special column of the data list, not as a timing diagram.

TIME WINDOW

See SEARCH AREA

WINDOW TRIGGER

Trigger words are searched within a program area referred to as the "window", which is defined by a beginning and an ending data word. First, the beginning of the window is identified. Then, a parallel search is done for both the trigger words anticipated to be found within the window, and for the word which signifies the end of the window area. If the searched for data word is not found within the window area, KLA triggers a jump back to the trigger level which corresponds to the beginning of the window.

CHAPTER 6

OPTIONS

This chapter has been intentionally left blank.

CHAPTER 7

SCHEMATICS/PIN ASSIGNMENTS

The schematics included in this chapter are subject to updates and revision changes. If you find differences between the specific hardware in your instrument, and some of the schematics, please call your Kontron Service number for assistance.

MP MASTER
MA23290

KONTRON
ELECTRONIC
GROUP

KONTRON MESSTECHNIK

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